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The Heavy Economic Toll of Gender-based Violence: Evidence from Sub-Saharan Africa

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ABSTRACT: The COVID-19 pandemic and lockdowns have led to a rise in gender-based violence. In this paper, we explore the economic consequences of violence against women in sub-Saharan Africa using large demographic and health survey data collected pre-pandemic. Relying on a two-stage least square method to address endogeneity, we find that an increase in the share of women subject to violence by 1 percentage point can reduce economic activities (as proxied by nightlights) by up to 8 percent. This economic cost results from a significant drop in female employment. Our results also show that violence against women is more detrimental to economic development in countries without protective laws against domestic violence, in natural resource rich countries, in countries where women are deprived of decision-making power and during economic downturns. Beyond the moral imperative, the findings highlight the importance of combating violence against women from an economic standpoint, particularly by reinforcing laws against domestic violence and strengthening women's decision-making power.

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WORKING PAPERS

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I. Introduction

The COVID-19 pandemic has led to an increase in domestic violence against women. The poor economic and social conditions coupled with the lockdown measures exacerbate existing abuse and control. For instance, according to one report by the International Growth Centre[1], the number of reported cases of gender-based violence increased from 300 in March to more than 700 in April following the introduction of lockdowns at the end of March in Nigeria. In Croatia, rape cases increased by 228 percent during the first 5 months of 2020 in comparison to 2019, and the percentage of attempted rapes rose by 175 percent (Böök et al., 2020). This is likely to be a lower-bound reporting, as working remotely during the COVID-19 pandemic has made reporting and seeking help even harder, particularly if a survivor is unable to leave the house to go to work or carry out other routine tasks (UN Women, 2020).

Globally, it is estimated that one in three women has experienced physical or sexual assault in her life (WHO, 2013).[2] Around the world, no place is less safe for a woman than her own home (Klugman et al., 2014). Besides being a fundamental human rights violation, a major public health concern, and devastating for individual well-being, violence against women and girls (VAWG) also has high economic costs. Channels through which VAWG creates "economic costs" include lower labor supply, reduced productivity per hour worked, less investment in human capital for both women and children, and possibly lower investment due to higher demand for health and judicial services. Domestic violence adversely affects companies, with costs associated with higher rates of absenteeism, staff turnover and presenteeism/reduced productivity, and the potential for reputational damage (ILO and UN Women, 2019).

According to UN Women (2016), the cost of violence against women (public, private and social) amounts to US$1.5 trillion at the global level. The World Bank (2018) found that violence against women can cost up to 3.7 percent of GDP in some countries. Although the sub-Saharan African region has the highest level of domestic violence against women, empirical studies about its potential economic impact are scarce, mainly due to data limitations. One study found that gender-based violence costs South Africa between 0.9 and 1.3 percent of GDP annually (KPMG, 2014), while another study revealed that violence against women and girls costs the Ghanaian economy around 0.9 percent of GDP (Raghavendra et al., 2019). However, these studies use accounting

[1] https://www.theigc.org/blog/the-shadow-pandemic-gender-based-violence-and-covid-19/. Accessed on December 20, 2020

[2] Violence against women and girls refers to: "any act of gender-based violence that results in, or is likely to result in, physical, sexual, or psychological harm or suffering to women, including threats of such acts, coercion, or arbitrary deprivation of liberty, whether occurring in public or in private life" (1993 UN Declaration on the Elimination of Violence against Women). Intimate partner violence is one of the most common forms of violence against women and girls but not identical, as it excludes acts of violence not perpetrated by intimate partners and includes violence against men or those with gender-nonconforming identities. The term gender-based violence is broader as it includes violence against men, boys, and sexual minorities or those with gender-nonconforming identities. "Violence" also comes in various forms, including sexual, physical or psychological violence, all of which are considered violence in this paper. We use the terms violence against women and girls, intimate partner violence, and domestic violence interchangeably for readability. They refer for the purpose of this paper to violence against women and girls committed by their intimate partners, including sexual, physical or psychological violence.

methods to estimate some direct costs related to such violence but do not take into account other factors that can affect the economy.

This paper proposes a novel approach to assess the economic impact of VAWG in 18 sub-Saharan countries across all income groups based on the Integrated Public Use Microdata Series (IPUMS) database. The data from this database was initially compiled by USAID's Demographic and Health Survey Program, covering country surveys from the 1980s to the present. The IMPUMS data contains information on the prevalence of violence against women and girls. We combine this data with the level of economic activity (approximated by nighttime light data per capita) for 224 districts in sub-Saharan Africa. By exploiting the cross-district variations, we attempt to answer the following questions:

- How does VAWG affect the level of economic development in sub-Saharan Africa?
- Is there any evidence that VAWG affects labor supply and human capital?
- How do protective laws against domestic violence, natural resources, decision-making power of women, and the business cycle affect the impact of VAWG on economic development?

Our analysis uses several types of violence against women, including physical (hurting, punching, slapping, etc.), emotional, and sexual violence. We also generate an aggregate index of violence against women and girls, which is the simple average of the different types of violence used in the paper. As for the empirical methodology, since economic activity could also affect the level of VAWG, we suggest an instrumental variable approach using the prevalence of violence against women and girls in neighboring districts as instrument. The use of the two stage least squares method allows us to address the endogeneity problem and identify the causal effect of violence against women on the economy. To explore the robustness of the results, we control for a wide range of possible determinants of the level of economic activity, exclude outliers, use an alternative measure of violence based on control and beliefs and use an alternative instrumental variable.

We find that violence against women and girls has a negative effect on economic activity. The results show that when the percentage of women subject to domestic violence declines by 1 percentage point, per capita nightlights-based economic activities increase by 8 percent. Our results provide empirical support for the channel through which violence against women and girls can affect economic activity, as we find that more violence is associated with a significant drop in female employment. Our results also show that violence against women is more detrimental to economic development in countries without protective laws against domestic violence, natural resource rich countries, where women are deprived of decision-making power and during economic downturns such as this pandemic crisis. In addition, we find that the economic cost of violence against women is higher in countries where the gender gap in education between partners is high. The results are robust to several alternative specifications. The findings imply that sub-Saharan African countries should strengthen laws to combat violence against women and reinforce women's decision-making power. Furthermore, promoting women's education will be key to reduce the gender gap in education and the influence and control by men. Sub-Saharan African countries should also address the increased levels of domestic violence during the COVID-19 crisis to bolster the economic recovery.

The paper contributes to the literature in several ways. First, it provides an empirical estimate of the economic costs of violence against women and girls using an empirical strategy that addresses the endogeneity issue. Most of the previous studies used a simple accounting method, which does not account for other factors affecting the economy, nor addresses the endogeneity issue between violence against women and economic activities (Raghavendra et al., 2019; KPMG, 2014). Second, to the best of our knowledge, this study is the first to look at the effect of several types of violence against women and uses a large sample of sub-Saharan African countries. The IPUMS database allows us to overcome several data limitations identified in previous studies. Third, we are able to investigate the existence of heterogeneities in the effect of violence against women on economic development, which is also unexplored in previous studies. This is particularly important as it helps identify some policy options to reduce the economic costs of violence against women.

The rest of the paper is organized as follows. Section 2 provides a brief review of the literature, while Section 3 describes the data sources. Section 4 focuses on the extent of violence against women in the world and in particular sub-Saharan Africa and presents some stylized facts. Section 5 describes the empirical strategy used in the paper, while Section 6 presents the results of the estimates. Section 7 focuses on the robustness checks of the results. Finally, Section 8 provides some concluding remarks.

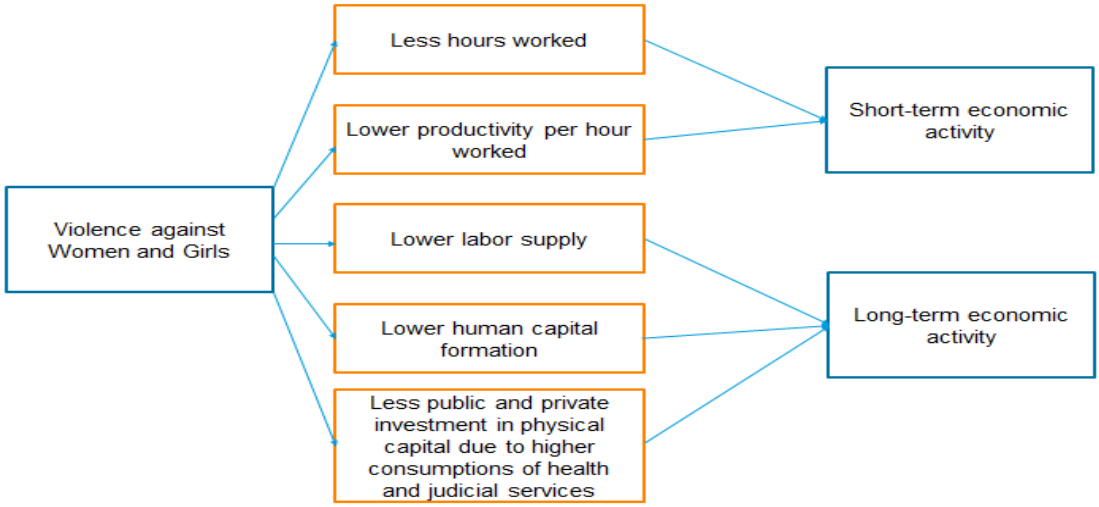
II. Brief Review of Literature

The main channels identified in the literature through which VAWG potentially affects economic growth are through less hours worked (absenteeism), reduced productivity per hour worked (presenteeism), lower longer-term labor supply (effect going beyond immediate effect due to violence)[3], less investment in human capital formation, and less investment in physical capital due to higher consumption of health and judicial services (see e.g., Duvvury et al. 2013). Figure 1 offers a stylized visualization.

Previous studies estimating lost output in a given time period used estimates of the prevalence and incidence rates of VAWG based on surveys and their impact on hours worked to gauge lost output. Duvvury et al (2013) estimate the impact for Vietnam, Bangladesh and Uganda. They combine data on VAWG with sectoral employment and output data to estimate the total output loss due to intimate partner violence (IPV). They find that the output loss in 2011 amounted to 1.6 percent of GDP in Vietnam, 1.28 percent of GDP in Bangladesh, and 1.27 percent in Uganda. Rhagavendra et al. (2019) use data from the 2016 women's survey across provinces in Ghana. They estimate that absenteeism and presenteeism due to VAWG reduced GDP growth by 0.94 percentage points in 2017. Other studies estimate annual monetary costs of VAWG. Duvvury et al. (2013) provide a comprehensive survey of studies that put a monetary value on some or all of the following: direct tangible costs (actual expenses, for example for health care), indirect tangible costs (lower earnings or profits for households and companies), direct intangible costs (e.g. pain and emotional stress) and indirect intangible costs (e.g. negative psychological effects on children who witness violence) (classification after Day et al. 2005). Relative to GDP, the studies often find costs in the range between 1.2 and 2 percent of GDP (Table 1).

[3] The empirical evidence whether VAWG is associated with lower longer-term labor supply is mixed. Farmer and Tiefenthaler (2004) for the US, Aguero (2012) for Latin American countries, and Morrison and Orland (2004) for Haiti, Peru and Zambia found that women who experienced physical violence were more likely to be employed. Findings by Meisel, Chandler et al. (2003), Romero, Chavkin et al. (2003), Lindhorst et al. (2007) and Crowne et al. (2011) by contrast, suggest that women experiencing violence are less likely to be employed.

Figure 1: Violence against Women and Girls and Economic Growth: Transmission Channels



Source: Authors, based on Duvvury et al. (2013)

Table 1. Selected costing studies of intimate partner violence

Author	Country	Type of Costs	Estimate	Percent of GDP
CDC (2003)	US (1995)	Annual health care cost, missed work, foregone earnings	US$ 5.8 billion	0.065
Access Economics (2004)	Australia	Service provision, economic costs, pain and suffering	$8.1 billion per year	1.2
Walby (2004)	UK	Service provision, Economic output and human and emotional costs	£23 billion/year	1.91
Orlando and Morrision (1999)	Nicaragua (1997)	Productivity loss	US$ 29.5 million	1.6
	Chile (1997)	Productivity loss	US$ 1.56 billion	2
Duvvury et al. (2012)	Vietnam (2011)	Out of pocket expenditures, missed work, productivity loss	US$ 1.71 billion	1.41
CARE (2010)	Bangladesh	Out of pocket expenditures and income loss due to missed work	US$ 1.8 billion	2.05

Source: Duvvury et al. (2013)

However, these cost estimate studies differ from our approach as the cost definition is usually broader than foregone economic activity and there are some sectoral coverage differences. Also, most studies rely on country specific information on incidence rates and assign unit values to the different types of costs before aggregation. By contrast, we study the effect on aggregate economic activity and try to infer the economic impact of VAWG by exploiting cross-regional variation.

Another key aspect of previous studies is that they do not address the endogeneity issue. The literature on determinants of VAWG highlights the potential endogeneity with economic activity. Wilson (2019) finds that education and household wealth are both negatively associated with intimate partner violence. Poverty and poor economic conditions are increasing the risk of experiencing violence as economic deprivation exacerbates stress in relationships, constrains media access, which predicts attitudes to wife beating, and poorer girls are likely to

marry earlier, increasing the risk of being physically abused. In this regard, it appears important to take into account the potential reverse effect of economic growth on violence against women. In this paper, we address this issue using an instrumental variable approach, allowing us to identify the causal effect of violence against women on economic activities.

III. Data sources and definitions

Our analysis is based on 29 integrated Demographic and Health Survey from the USAID's DHS Program from 18 sub-Saharan African countries (see Table A1 in appendix) from the 1980s to the present.[4] The Integrated Public Use Microdata Series database includes nationally representative samples of country censuses that correspond typically to 10 percent of the full census of each country. Although the samples belong to different years, they are harmonized by the Minnesota Population Center for comparability of variables across countries and over time. Our sample covers more than 440,000 women, representative of around 75 percent of sub-Saharan Africa's female population. IPUMS also reports information on respondents' current residence, allowing us to assign individuals to their current administrative units. We rely on each country second or third administrative unit, which are typically districts or provinces according to the administrative division of each country. The sample covers 224 districts. The estimates are performed at the district level to gain variability and improve the statistical properties of our results.

Regarding the indicators of VAWG by intimate partners, we relied on various questions about women experience of mistreatments by husbands, including punching with fist or something harmful, slapping, pushing or throwing something, threatening with harm, emotional and sexual violence. We considered another variable indicating whether women had visible marks of harm from violent acts by their intimate partner. For each variable, we calculated the share of women who were subject to intimate partner violence at the district level. We also constructed a composite index of domestic violence, which is the simple average of these abovementioned variables related to domestic violence.

As for the measurement of economic development at the district level, we use satellite data on nighttime lights provided by National Oceanic and Atmospheric Administration. The most commonly used measure for economic activity, gross domestic product, is not available at the district level. Recent studies have shown that nightlight satellite data is highly correlated with economic activities, with a coefficient of correlation up to 70 percent (Hu and Yao, 2019; Pinkovskiy and Sala-i Martin, 2016). The use of nightlight satellite data to proxy economic activity at the sub-national level is growing (Mamo et al. 2019, Dreher and Lohmann, 2015; Henderson et al., 2012; Chen and Nordhaus, 2011). The data is cleaned luminosity, after filtering for cloud coverage, other ephemeral lights, and background noise. Nighttime lights are available at the pixel-year level (roughly 0.86 square kilometers at the equator) since 1992. For each pixel, 30 different satellites provide a light digital number (DN) ranging from 0 (unlit) to 63 (top-coded). For this study, we calculated nightlights per capita by dividing the sum of all nighttime light pixel values within a district by the district's population. The data on the population is from the Gridded

[4] We extracted the data from IPUMS (Integrated Public Use Microdata Series) Global Health, hosted by the University of Minnesota Population Centre. The original data are from USAID's DHS program, and sampling and methodology per country can be found here: https://dhsprogram.com/

Population of the World, Version 4 database provided by the Center for International Earth Science Information Network.

Finally, we control for a set of variables that are documented to be strong determinants of economic development, including the size of the agriculture sector captured by the share of cropland and urbanization rate proxied by the share of respondents living in urban areas. These data are from the IPUMS dataset. To capture the role of infrastructure, we used the time to water source, which is from the IPUMS dataset, and the total road lengths from the Center for International Earth Science Information Network (2013). We also include education, which is defined as the average number of years of schooling, and the number of conflict-related deaths over population, both from IPUMS. Based on the religious beliefs of respondents, we constructed a religious fractionalization index following the Montalvo and Reynal-Querol (2005) methodology. The descriptive statistics are in Table A2 in appendix.

IV. Descriptive statistics and Stylized facts

A. Extent of violence against women

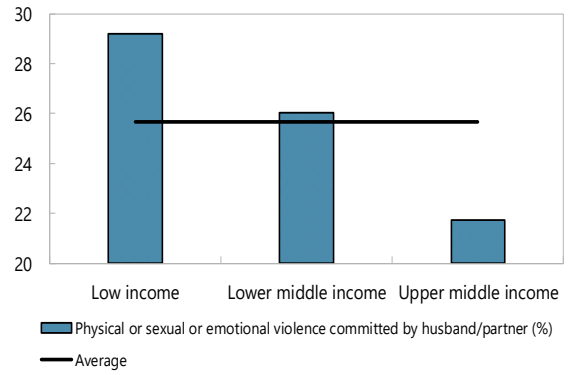
Figure 2 shows that physical, sexual and emotional violence against women is pervasive in the world as measured by the USAID's DHS program. On average, more than one quarter of women experienced intimate partner violence in recent years. The level of such violence is higher in low-income countries than in middle-income countries.[5] In low-income countries, nearly one-third of women experienced domestic violence, against around one fifth of women in upper middle-income countries. Furthermore, we observe that there are some differences across regions in the world. The sub-Saharan African region has the highest rate of domestic with more than 30 percent of women who had experienced intimate partner violence, followed by the East Asia and Pacific region. In South Asia, less than 20 percent of women have experienced domestic violence in recent years.

Figure 3 shows that the prevalence of domestic violence against women varies between countries. In Afghanistan, Papua New Guinea, Liberia, and Democratic Republic of Congo, nearly half of all women experienced physical, sexual or emotional violence committed by a husband or partner. In the Top 10 countries with the highest rate of domestic violence, there are 7 countries from the sub-Saharan African region. On the other hand, in Armenia, Comoros, Maldives and Azerbaijan, around 10 percent of women ever experienced intimate partner violence.

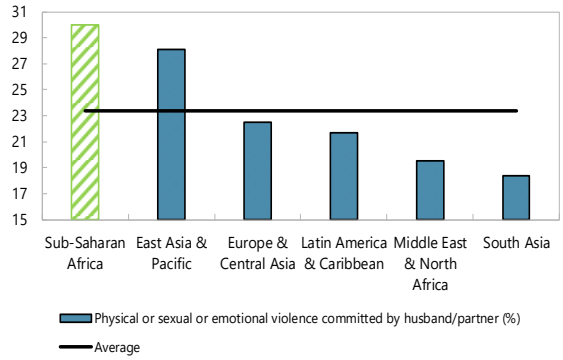
[5] List of countries: Afghanistan, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Chad, Colombia, Comoros, Congo Democratic Republic, Cote d'Ivoire, Dominican Republic, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guatemala, Haiti, Honduras, India, Jordan, Kenya, Kyrgyz Republic, Liberia, Malawi, Maldives, Mali, Moldova, Mozambique, Myanmar, Namibia, Nepal, Nigeria, Pakistan, Papua New Guinea, Peru, Philippines, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Tajikistan, Tanzania, Timor-Leste, Togo, Uganda, Ukraine, Zambia, and Zimbabwe. Classification follow World Bank's classification of countries by income groups: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Figure 2: Domestic Violence by Income Group and Region

1.A. By income group

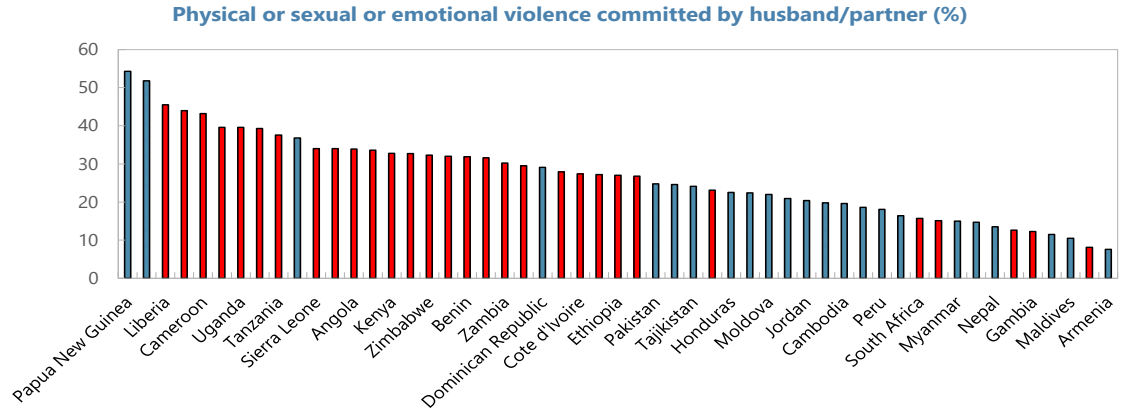


1.B. By region



Source: USAID's DHS Program and Authors' calculations

Figure 3: Domestic violence by country



Source: USAID's DHS Program and Authors' calculations

Women are subject to different types of domestic violence. Table 2 provides the features of 7 types of violence in sub-Saharan Africa. This comparative analysis of Demographic and Health Survey (DHS) data shows that the percentage of ever-partnered women who reported ever experiencing any physical, emotional or sexual violence by their current husband or partner ranges from 1.1 percent in Comoros to 17.8 percent in Gabon for punching with fist or something harmful, 1.5 percent in Burkina Faso to 27.1 percent in Democratic Republic of Congo for sexual violence and from 5.5 percent in Comoros to 47 percent in Gabon for emotional violence. We also observe that slapping is very frequent, with more than one third of women reporting being slapped by husband or partner in Gabon, Democratic Republic of Congo, Sierra Leone and Zambia. Table 2 shows that threat of harm is common, as nearly 20 percent of women reported ever experiencing threat with harm in Cameroon, Democratic Republic of Congo and Uganda. As a result, the percentage of women who presented physical results of violence by husband is very high in these countries.

Table 2: Type of domestic violence

Country	Any physical results of husband's actions (%)	Ever punched with fist or something harmful (%)	Ever slapped (%)	Ever pushed, shook, or threw something (%)	Ever threatened with harm (%)	Ever experienced any emotional violence (%)	Ever experienced any sexual violence from partner (%)
Angola	11.8	11.1	29.4	10.6	7.2	25.0	7.8
Burkina Faso	3.6	5.8	8.7	4.2	6.5	9.8	1.5
Burundi	18.8	10.9	36.5	14.1	7.0	25.5	25.6
Cameroon	17.8	16.9	36.4	21.9	19.7	36.9	15.1
Comoros	…	1.1	4.0	3.0	0.4	5.5	1.7
DR Congo	23.4	14.3	40.6	26.0	19.3	38.3	27.1
Cote d'ivoire	8.1	13.0	19.8	10.6	7.5	18.0	5.1
Ethiopia	6.1	6.7	15.9	11.5	7.2	22.3	7.6
Gabon	…	17.8	42.0	24.9	3.6	47.0	15.5
Gambia	…	2.9	14.9	5.1	0.6	17.3	2.9
Ghana	8.7	5.0	16.6	9.4	9.0	33.0	6.7
Kenya	13.3	13.3	31.2	19.7	14.4	27.7	13.0
Malawi	9.1	8.7	17.9	8.1	9.0	20.7	15.8
Mali	5.0	8.6	15.5	6.2	6.2	16.1	6.5
Mozambique	6.3	10.7	26.9	9.2	5.4	34.9	7.8
Namibia	8.4	13.0	18.8	15.6	12.0	25.3	7.3
Nigeria	5.0	3.8	14.7	6.3	6.1	21.2	4.8
Rwanda	11.3	11.5	28.3	15.4	9.0	18.8	15.0
Senegal	5.8	7.9	15.2	5.5	4.9	13.4	6.3
Sierra Leone	…	8.8	37.4	21.1	1.3	40.0	6.6
South Africa	5.1	…	…	12.8	6.2	18.7	3.5
Tanzania	25.2	16.8	31.8	15.4	8.2	31.8	12.6
Chad	…	7.7	20.6	10.3	1.3	22.4	8.9
Togo	…	9.4	19.6	10.0	0.8	21.6	8.1
Uganda	19.4	17.1	36.5	21.1	19.4	42.6	24.7
Zambia	14.6	13.0	36.8	14.6	9.3	25.0	17.0
Zimbabwe	11.8	10.5	25.1	10.6	10.4	29.1	13.3

Source: IPUMS and Authors' calculations

Table 3 presents the change in domestic violence for countries with more than one demographic and health survey. As all countries in the table have at least one survey before or in 2010 and one after 2010, we also present the average for each type of domestic violence at the bottom of the table. Table 3 shows that all types of domestic violence have increased in the last decade compared to the 2000s, except punching with fist or something harmful which remained almost unchanged. There are also some heterogeneities between countries and type of violence. For instance, Zimbabwe has seen an increase of all types of violence, except sexual violence, while Democratic Republic of Congo has experienced a decline in domestic violence, though from a very high level. Mali has also experienced an increase in domestic violence between 2006 and 2012, which could be linked to rising insecurity since 2011.

Table 3: Change in domestic violence

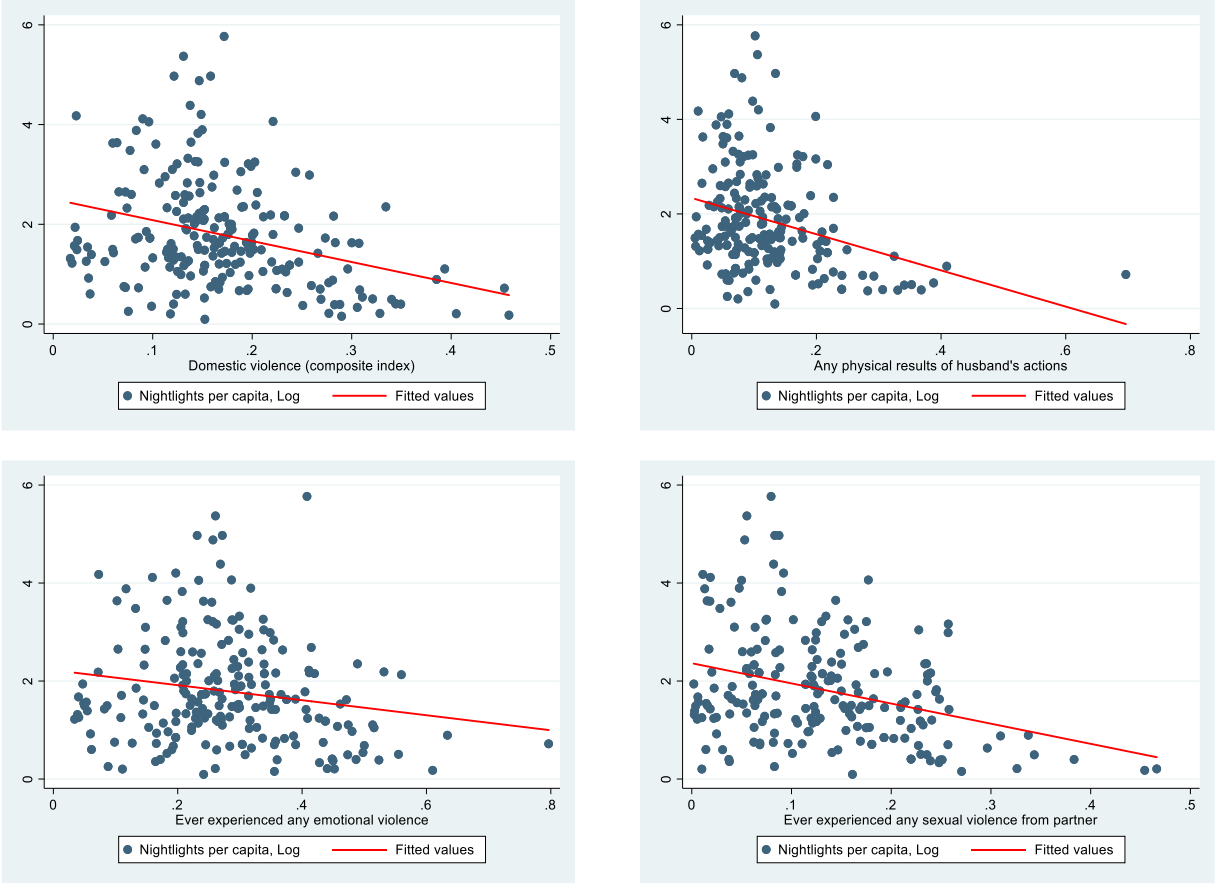
VARIABLES	Years	Any physical results of husband's actions (%)	Ever punched with fist or something harmful (%)	Ever slapped (%)	Ever pushed, shook, or threw something (%)	Ever threatened with harm (%)	Ever experienced any emotional violence (%)	Ever experienced any sexual violence from partner (%)
Cameroon	2004	…	17.5	33.0	19.5	20.7	30.7	…
Cameroon	2011	17.2	16.9	38.7	23.1	19.3	40.5	14.7
Difference		**…**	***-0.6***	***5.7***	***3.6***	***-1.4***	***9.8***	**…**
DR Congo	2007	…	19.5	43.2	31.0	29.7	42.3	30.3
DR Congo	2013	22.5	11.6	39.3	22.7	13.6	35.5	24.5
Difference		**…**	***-7.9***	***-3.9***	***-8.2***	***-16.1***	***-6.8***	***-5.8***
Kenya	2003	13.9	16.0	32.4	22.1	16.0	23.4	15.1
Kenya	2008	11.7	11.0	30.7	17.9	13.9	27.6	12.4
Kenya	2014	13.9	11.7	29.2	18.3	12.6	29.0	11.0
Difference		***2.2***	***0.7***	***-1.5***	***0.4***	***-1.3***	***1.4***	***-1.3***
Malawi	2010	10.3	9.1	18.3	9.2	12.7	25.7	16.5
Malawi	2016	10.8	9.4	21.6	9.1	12.8	28.5	18.6
Difference		***0.5***	***0.2***	***3.2***	***-0.2***	***0.0***	***2.8***	***2.1***
Mali	2006	4.1	8.3	12.0	5.5	5.5	10.1	3.4
Mali	2012	7.1	7.2	23.7	7.7	7.8	32.4	14.4
Difference		***3.0***	***-1.2***	***11.7***	***2.2***	***2.4***	***22.3***	***10.9***
Nigeria	2008	6.3	5.2	18.2	6.6	7.6	23.0	4.7
Nigeria	2013	5.4	4.2	15.0	8.0	7.5	22.2	5.6
Difference		***-0.9***	***-1.0***	***-3.2***	***1.4***	***-0.1***	***-0.8***	***1.0***
Tanzania	2010	24.1	16.9	33.7	15.8	8.5	33.5	13.9
Tanzania	2015	26.9	17.9	31.6	16.1	8.3	31.5	12.2
Difference		***2.7***	***0.9***	***-2.1***	***0.2***	***-0.2***	***-2.0***	***-1.7***
Zambia	2007	12.8	14.6	40.7	11.9	10.3	25.8	17.3
Zambia	2013	14.9	12.2	34.5	15.7	9.0	24.5	17.2
Difference		***2.1***	***-2.3***	***-6.2***	***3.8***	***-1.3***	***-1.3***	***-0.1***
Zimbabwe	2005	13.6	12.6	25.1	11.6	10.2	30.0	13.0
Zimbabwe	2010	9.4	9.2	23.3	9.2	8.8	25.2	14.1
Zimbabwe	2015	12.4	9.7	25.1	10.8	11.2	30.7	11.2
Difference		***3.0***	***0.5***	***1.9***	***1.6***	***2.4***	***5.5***	***-2.8***
Total	Before 2010	11.8	11.4	26.0	12.2	10.4	24.9	12.3
	After 2010	14.6	11.2	28.7	14.6	11.3	30.5	14.4
	Difference	***2.8***	***-0.2***	***2.7***	***2.4***	***1.0***	***5.6***	***2.1***

Note: For countries with 3 years of observations, the difference is based on the latest 2 years.

B. Relationship between violence and economic variables

Figure 4 presents the relationship between nightlights per capita and domestic violence against women at the district level in sub-Saharan Africa. It shows that there is a negative correlation between domestic violence and nightlights per capita. This relationship holds for both the composite index and the selected different types of intimate partner violence, including physical, emotional and sexual violence. We also observe that the strength of the correlation differs according to the type of violence.

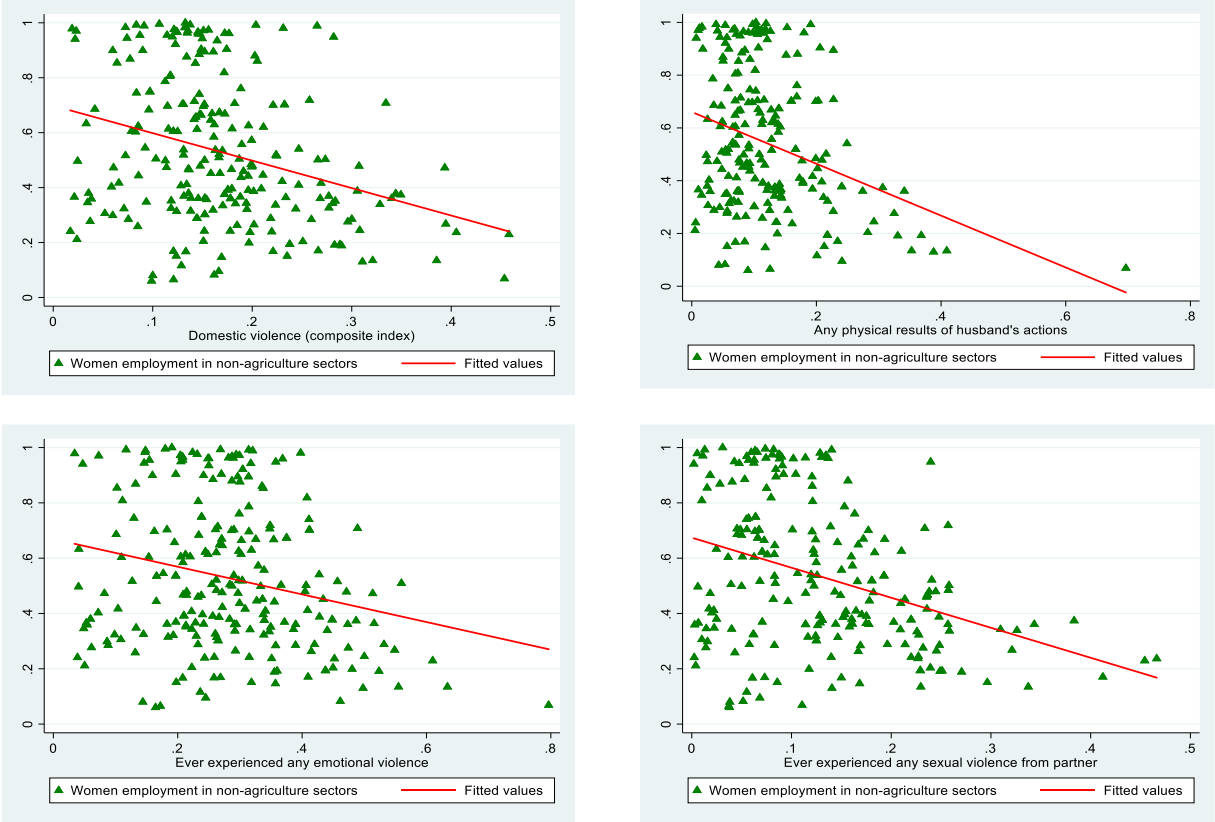
Figure 4: Relationship between domestic violence and nightlights per capita



Source: Authors' calculations

In Figures 5, we present the relationship between domestic violence and female employment, which is the transmission channel considered in this paper. Figure 5 displays the correlation between intimate partner violence measured by the composite index and the three different types of violence and female employment in the non-agriculture sectors (unpaid jobs also excluded). It shows a clear negative correlation between the share of women working in the non-agriculture sectors and the percentage of women reporting being subject to domestic violence.

Figure 5: Relationship between domestic violence and female employment



Source: Authors' calculations

V. Empirical methodology

We aim to estimate the impact of intimate partner violence against women on nightlights per capita. Our empirical specification is as follows:

$$Nightlights_{ij,t} = \alpha + \beta Violence_{ij,t} + \gamma X'_{ij,t} + \pi_j + \emptyset_t + \mu_{ij,t} \ , \qquad (1)$$

where, for district i from country j at time t, $Nightlights_{ij,t}$ represents nighttime lights per capita, $Violence_{ij,t}$ is the share of women who experienced domestic violence, Vector $X'_{ij,t}$ includes several variables that are traditionally considered as determinants of economic development (Mamo et al. 2019; Egert et al. 2009; Alesina et al. 2003; Barro, 2001; Alesina et al. 1996) . These variables comprise of the share of the agriculture sector, the urbanization rate, the time to reach water source, the total lengths of roads, education, conflict and religious fractionalization index. π_j and $\emptyset_t$ are country and time fixed effects, respectively. The inclusion of these fixed effects will account for any country-specific and time-invariant characteristics that may affect nightlight per capita. $\mu_{ij,t}$ is the error term.

The main challenges for estimating the causal effect of domestic violence on nightlights per capita are reverse causality, omitted and unobservable variables, and measurement errors. First, the level of economic development could affect the level of domestic violence. A current example where the direction of causality is likely to go from economic (and broader social) activity to domestic violence is the current COVID-19 pandemic. Several reports have emphasized spikes in domestic violence during the pandemic (UN Women, 2020). Second, some variables may be subject to measurement error. For example, measuring the prevalence of intimate partner violence through surveys could be inaccurate as generally victims of domestic violence tend to underreport either because of fear of retaliation, privacy concerns or other societal factors (Felson et al. 2006; Krantz, 2002). Third, there are many potential variables affecting the level of economic activity at a given point in time and it is difficult to know if key control variables are missing, and other unobserved variables that could affect both economic activity and domestic violence (e.g. cultural and social norms, economic inequality) . Consequently, estimating equation (1) using ordinary least squares (OLS) method could lead to biased results.

To address endogeneity, we employ an instrumental variable approach - the two-stage least squares (2SLS) method. We use the average level of domestic violence in neighboring districts as instrument for domestic violence in a given district. Neighboring districts are defined as those that have the same borders. In order to use the average level of gender-based violence in bordering countries as an instrument, two conditions should be met: (i) the instrument needs to be relevant (i.e., gender-based violence in bordering districts needs to be correlated with the level of gender-based violence in a given district) and (ii) the instrument should be exogenous (i.e., gender-based violence in bordering districts should be uncorrelated with nightlights per capita in a given district or the error term in equation (1)).

Focusing on the relevance of the instrument, the intuition is that regional cultural closeness and communities could lead neighboring districts to share some common values and behaviors. It is natural that being physically close to each other facilitates communication, social interaction, diffusion of cultural values and learning across different societies, and therefore people may tend to share common behaviors such as the acceptance of domestic violence. In this regard, we are strongly confident that the level of domestic gender-based violence in neighboring districts is a good predictor of domestic violence in a given district. Several papers have used similar instrumental variables in recent studies (Acemoglu et al. 2019; Caselli and Reynaud, 2019; Cherif et al, 2018). Regarding the exogeneity of the instrument, as Cherif et al. (2018) emphasized, a country could be affected by spillovers from its neighbors mostly, but not exclusively, through trade and finance. To address this issue that could invalidate the exogeneity of the instrument, they controlled for the average real GDP per capita in neighboring countries as a proxy for the spillover effect. In this paper, we follow this approach and control for the average nightlights per capita in bordering districts in the second stage. Furthermore, as in Acemoglu et al. (2019) and Cherif et al. (2018), we control for time and district fixed effects that could affect nightlights per capita, enabling us to parametrically remove the influence of unobserved fixed characteristics that are common to districts. After controlling for the spillover effects and all the fixed effects, we believe that the exclusion restriction is satisfied.

VI. Results

A. Baseline results: OLS

We report in Table 4 the results of the estimates of the impact of domestic violence on nightlights per capita using the ordinary least squares method. In this table, we use the composite index described in Section III as a measure of domestic violence. In columns (1) and (2), we do not include the control variables, which are considered in columns (3)-(7). The impact of domestic violence against women, captured by the coefficient associated with the variable "*violence against women*" is negative and strongly significant in all columns, regardless of whether or not we control for the traditional determinants of economic development (columns 3-7) or include or not the time and country fixed effects. Column (6) includes all fixed effects and is considered as the baseline. This result suggests that an increase in domestic violence is associated with lower nightlights per capita. In column 7, we control for the level of violence against men related to situations where women fight back. Although the coefficient associated with this variable is negative, it is not statistically significant. However, the coefficient associated with the variable violence against women remains negative and strongly significant at the 1 percent level. In Table A3 (in appendix), we use separately the variables used to construct the composite index and estimate their impact on nightlight per capita. As can be observed, the coefficients associated with all these variables are negative and significant.

Regarding the control variables, they are broadly in line with the literature. We find that the coefficients associated with the share of the urban area, the length of roads and the level of education are positive and significant. As emphasized in the literature, education and infrastructure positively affect economic development (Barro and Sala-i-Martin, 1995; Mankiw et al., 1992). On the contrary, the coefficients associated with the share of the agriculture sector, time to water source, conflict and religious fractionalization are negative and significant. These findings are consistent with previous studies that highlighted that religious fractionalization and conflict reduce economic activity (IMF, 2019; Montalvo and Reynal-Querol, 2005; Alesina et al.,1996).

B. Baseline results: IV approach

As explained in Section V, the results in Table 2 could be subject to some endogeneity issues due to reverse causality and omission of variables. To tackle this problem, we instrument domestic violence in a given district with the level of violence in neighboring districts. The results are reported in Table 5. At the bottom of the table, we present the statistical tests about the strength of our instrument. Table 5 suggests that our instrument performs very well in the first stage. In fact, the coefficient associated with domestic violence in neighboring districts is positive and significant at the 1 percent level in all columns, suggesting that it is a good predictor of domestic violence in a given district. The different statistical tests do not invalidate the econometric method. Based on the F-test of the exogeneity of the instrumented variable, we can reject the null hypothesis of no endogeneity. The Cragg-Donald, Kleibergen-Paap and the Anderson-Rubin tests regarding the strength of the instrument are strongly significant; therefore, we reject the hypothesis that our identification strategy is weak.

In column (1), we use the composite index of domestic violence, while in columns (2)-(8), we use each of the components of the index. From the outset, we observe that the coefficients associated with violence against women are higher in Table 5 than in Table 4 and Table A3, suggesting there is a downward bias when the

ordinary least squares method is used. Also, they are negative and highly significant at the 1 percent level in all columns. Thus, intimate partner violence against women reduces economic activity in Africa. Based on column (1) where we use the composite index, an increase of domestic violence against women by 1 percentage point could reduce nightlights per capita by 8.7 percent.

The results also show the impact of violence against women on nightlights per capita also depends on the type of violence. In fact, threatening with harm, punching with fist or something harmful and causing emotional violence appears to more significantly reduce nightlight per capita than the other types of violence.

Table 4: Baseline results using the OLS method

Dependent variable: nighttime light per capita							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Violence against women	-2.1349***	-3.1402***	-1.9924**	-2.3077***	-1.9586**	-2.2281***	-1.8488***
	(0.773)	(0.653)	(0.884)	(0.622)	(0.878)	(0.635)	(0.643)
Agriculture			-0.5139*	0.2695	-0.6967**	0.2043	0.1145
			(0.284)	(0.190)	(0.282)	(0.196)	(0.197)
Urban area			0.8376**	1.0353***	1.0795***	1.0838***	1.1464***
			(0.378)	(0.212)	(0.352)	(0.223)	(0.228)
Time to water source			-0.0295***	-0.0072**	-0.0294***	-0.0085**	-0.0076**
			(0.005)	(0.003)	(0.005)	(0.004)	(0.003)
Roads			0.0217	0.0614***	0.0345**	0.0595***	0.0588***
			(0.019)	(0.015)	(0.015)	(0.015)	(0.015)
Education			0.2670*	0.5004***	-0.1478	0.4037***	0.3947**
			(0.157)	(0.137)	(0.144)	(0.153)	(0.153)
Conflict			-0.3266***	-0.1233***	-0.2017***	-0.1139***	-0.1225***
			(0.068)	(0.025)	(0.040)	(0.027)	(0.028)
Religious fractionalization			-0.8212***	-0.1501	-1.0781***	-0.2646	-0.1777
			(0.304)	(0.290)	(0.296)	(0.315)	(0.314)
Violence against men							-1.2912
							(1.462)
Constant	1.4496***	2.0134***	2.1028***	-1.8059***	2.0943***	-1.6192***	1.8275***
	(0.166)	(0.235)	(0.286)	(0.484)	(0.261)	(0.482)	(0.251)
Observations	358	358	337	337	337	337	328
R-squared	0.018	0.691	0.296	0.782	0.398	0.784	0.789
District fixed effects	No	Yes	No	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes	Yes
Country fixed effects	No	Yes	No	No	Yes	Yes	Yes

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

Table 5: Baseline results: IV approach

Dependent variable: nighttime light per capita									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Composite index	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner	Composite index
Violence against women	-8.6954***	-5.8041***	-15.2377***	-5.1007***	-8.0035***	-18.0609***	-13.1572***	-8.2545***	-8.7221***
	(1.285)	(0.944)	(3.113)	(0.813)	(1.061)	(4.224)	(3.928)	(1.360)	(1.461)
Agriculture	0.1509	0.1833	0.4078	0.2776	-0.0103	-0.2362	0.2631	0.1230	0.1722
	(0.219)	(0.210)	(0.322)	(0.217)	(0.209)	(0.357)	(0.434)	(0.217)	(0.229)
Urban area	0.5064	0.6925**	0.5234	0.5271	0.7612***	0.5754	0.7103	-0.2481	0.3228
	(0.308)	(0.318)	(0.413)	(0.322)	(0.276)	(0.400)	(0.539)	(0.316)	(0.337)
Time to water source	0.0015	0.0019	0.0070	-0.0022	-0.0003	0.0033	0.0204	-0.0080	0.0012
	(0.006)	(0.006)	(0.010)	(0.006)	(0.005)	(0.008)	(0.017)	(0.005)	(0.006)
Roads	0.0541***	0.0587***	0.0613***	0.0572***	0.0599***	0.0628***	0.0324	0.0468***	0.0614***
	(0.014)	(0.015)	(0.016)	(0.014)	(0.013)	(0.018)	(0.024)	(0.012)	(0.015)
Education	0.8255***	0.3376*	0.8858***	0.7232***	0.6842***	1.6658***	1.4602***	0.9108***	0.7589***
	(0.222)	(0.190)	(0.284)	(0.207)	(0.188)	(0.452)	(0.564)	(0.228)	(0.221)
Conflict	-0.0838**	-0.0392	-0.0912***	-0.0527	-0.0926***	-0.2574***	-0.1520***	-0.0573	-0.0548
	(0.033)	(0.037)	(0.034)	(0.045)	(0.027)	(0.066)	(0.056)	(0.042)	(0.039)
Religious fractionalization	0.3047	-0.7110**	0.7003	0.0127	0.2016	-0.2266	-1.3892*	-0.1292	0.3664
	(0.322)	(0.339)	(0.457)	(0.311)	(0.282)	(0.430)	(0.776)	(0.329)	(0.323)
Neighbors' nighlight per capita	0.2521**	0.3325***	0.1761	0.2494**	0.2348**	0.1105	0.0973	0.3783***	0.3064***
	(0.117)	(0.114)	(0.141)	(0.118)	(0.113)	(0.168)	(0.180)	(0.122)	(0.117)
Violence against men									3.4935
									(2.161)
Constant	-0.5025	-0.6688	-1.0280	-0.2185	-0.5941	-1.0231*	-0.9219	0.1620	-0.4788
	(0.453)	(0.447)	(0.649)	(0.426)	(0.379)	(0.617)	(0.980)	(0.392)	(0.453)
First stage									
Neighbors' domestic violence	0.8817***	1.3498***	0.5041***	1.5061***	0.9599***	0.4253***	0.5839***	0.9282***	0.8984***
	(0.107)	(0.136)	(0.094)	(0.188)	(0.106)	(0.109)	(0.178)	(0.132)	(0.111)
Observations	337	318	337	337	337	337	337	327	328
R-squared	0.684	0.711	0.396	0.682	0.727	0.286		0.691	0.688
F-test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	87.89	111.07	32.00	95.40	106.85	20.86	12.17	78.70	82.80
Kleibergen-Paap rk LM statistic	37.81	56.64	21.65	37.47	38.12	11.69	10.20	32.94	41.79
Anderson-Rubin Wald test	61.02	52.69	61.02	61.02	61.02	61.02	61.02	60.63	53.25
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

C. Transmission channel: female employment

Next, we examine the evidence for the channel through which VAWG could undermine economic activity: labor supply. For the employment channel, ideally one would have data on annual hours worked by women to assess the effects of intimate partner violence on labor supply. In its absence, we rely on women's participation in the official labor markets (thus excluding agriculture, informal and unpaid jobs). This implicitly assumes that the only way domestic violence affects labor supply is by discouraging women from participating in the formal labor market. But domestic violence also reduces labor supply through reduced hours worked per day or missed working days while an affected woman would still be participating in the labor market. Adding to the exclusion of

agriculture, informal and unpaid jobs, the proxy is therefore likely to underestimate the impact of domestic violence on labor supply.

There is an extensive literature on the relationship between employment and domestic violence. In this paper, we are exploring the causal effect of domestic violence on female employment. Physical, psychological and emotional violence can affect women's ability to achieve or maintain employment. Previous studies have found that experiencing intimate partner violence is associated with increased absenteeism over the long term and presenteeism in the short term through tardiness, not showing up for work, and use of sick days as well as problems with concentration, job performance, and productivity (Reeves and O'Leary-Kelly, 2007; Swanberg et al., 2005; Brush, 2002). Other studies point out that women who are in abusive relationships tend to experience high rates of job loss and turnover and many times are forced to quit or are fired (Swanberg and Logan 2005; Bell, 2003). Some research papers also emphasize that in comparison to non-abused women, abused women sustain two to three times more injuries that require surgery and tend to be socially excluded, making them less likely to be employed (Damonti, 2014; Campbell, 2002).

The IPUMS dataset contains some data about female employment status. To explore whether women who experience domestic violence are less likely to work, we estimate equation (2) with the share of working women as the dependent variable:

$$Femaleemp_{ij,t} = \omega + \varphi Violence_{ij,t} + \tau Y'_{ij,t} + \theta_j + \mu_t + \delta_{ij,t} \ , \qquad (2)$$

With $Femaleemp_{ij,t}$ being the share of working women for district i from country j at time t, $Violence_{ij,t}$ is for violence against women, $Y'_{ij,t}$ stand for the other control variables including the share of women living in urban area, the length of primary roads, the level of education, conflict and religious fractionalization. . θ_j and μ_t are country and time fixed effects, respectively, while $\delta_{ij,t}$ is the error term.

We instrument domestic violence in a given district with the level of domestic violence in the neighboring districts in order to rule out the issue of reverse causality between employment and domestic violence, and therefore identify the causal effect of domestic violence on female employment. The estimates are performed for the composite index and with each of its components. The results are reported in Table 6. They show that the coefficient associated with violence against women is negative and highly significant at the 1 percent level in all columns, suggesting that women who are subject to domestic violence are less likely to work. This finding is consistent with some previous works (Damonti, 2014; Campbell, 2002). Based on column (1), an increase in the share of women who experienced domestic violence by 1 percentage point would reduce female employment rate by 2.5 percentage points.

Table 6: Impact of violence against women on female employment

Dependent variable: female employment (%)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Composite index	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner
Violence against women	-2.4739***	-1.8859***	-4.1169***	-1.4423***	-2.5468***	-4.9106***	-3.0099***	-2.3304***
	(0.403)	(0.293)	(0.947)	(0.276)	(0.479)	(1.251)	(0.695)	(0.365)
Urban	0.4696***	0.5419***	0.4244***	0.4980***	0.5656***	0.4278***	0.3864***	0.3507***
	(0.064)	(0.060)	(0.090)	(0.066)	(0.061)	(0.095)	(0.085)	(0.077)
Roads	-0.0015	-0.0011	-0.0007	-0.0009	0.0017	0.0009	-0.0089	-0.0033
	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.005)	(0.006)	(0.003)
Education	0.1910***	0.0635	0.1733**	0.1656***	0.1697**	0.4020***	0.2537***	0.2531***
	(0.061)	(0.058)	(0.077)	(0.060)	(0.069)	(0.117)	(0.076)	(0.065)
Conflict	0.0042	-0.0159**	0.0049	-0.0143**	-0.0031	-0.0383*	-0.0043	0.0107
	(0.006)	(0.007)	(0.010)	(0.007)	(0.007)	(0.021)	(0.009)	(0.007)
Religious fractionalization	-0.0741	0.0355	0.0012	-0.1793*	-0.0184	-0.2148	0.0807	-0.2398***
	(0.101)	(0.106)	(0.145)	(0.101)	(0.126)	(0.145)	(0.139)	(0.089)
Constant	0.2408***	0.2189***	0.4092***	0.2878***	0.1784**	0.1456	0.3212***	0.1715**
	(0.070)	(0.068)	(0.105)	(0.067)	(0.077)	(0.109)	(0.113)	(0.072)
First stage								
Neighbors' domestic violence	0.9454***	1.4268***	0.5356	1.5288***	0.9183***	0.4763***	0.7771***	1.0047***
	(0.097)	(0.136)	(0.092)	(0.176)	(0.106)	(0.102)	(0.168)	(0.120)
Observations	358	339	351	351	358	358	358	348
R-squared	0.508	0.496	0.318	0.544	0.386	0.315	0.304	0.526
F-test, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	119.99	143.80	37.03	103.07	111.36	31.63	25.43	113.69
Kleibergen-Paap rk LM statistic	46.37	61.55	24.29	41.01	38.14	15.66	18.06	39.41
Anderson-Rubin Wald test	41.16	42.29	31.17	31.17	41.16	41.16	41.16	41.04
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

Having established that violence against women reduces female employment, we now test whether the effect of violence against women on economic activity partially or totally transmit though the decline in female employment. To this end, we include female employment in the baseline estimates. If the magnitudes of the coefficients associated with violence against women remain unchanged, violence against women influences economic activity even in the absence of decline in female employment. However, if the coefficients associated with violence against women are reduced or become insignificant, then the effect of violence against women on economic activity can be assumed to operate through a simultaneous occurrence of a reduction in female employment. If the coefficients associated with violence against women increase, then violence against women has a bigger effect on economic activity than just through the female employment channel. The results are

reported in Table 7. We find that the coefficient associated with violence against women remains negative and statistically significant at the 1 percent level in all columns. However, their magnitudes are now lower than in Table 5. This result suggests that the adverse effect of violence against women on economic activity is partially explained by the reduction in female employment. As explained above, our proxy is likely to underestimate the potential effect of violence against women on labor supply, and we acknowledge that there are other channels through which gender-based violence can affect economic activities, including labor productivity, public health, human capital, the allocation of resources, etc.

Table 7: Transmission channel: female employment

Dependent variable: nighttime light per capita								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Composite index	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner
Violence against women	-6.4237***	-5.0560***	-7.9872***	-3.4054***	-6.3482***	-11.2991***	-3.4483*	-4.4004***
	(1.298)	(1.134)	(1.177)	(0.620)	(1.163)	(3.439)	(1.881)	(1.223)
Female employment	0.7026**	0.4127**	0.8931***	0.9043**	0.7523***	0.5466**	2.4964**	0.9098**
	(0.354)	(0.195)	(0.219)	(0.380)	(0.140)	(0.184)	(0.888)	(0.408)
Agriculture	0.1888	0.2189	0.5210	0.3588	-0.0090	-0.2388	0.4772	0.1552
	(0.243)	(0.221)	(0.405)	(0.249)	(0.214)	(0.358)	(0.753)	(0.241)
Urban area	0.9291**	0.9605**	1.0650*	1.0764**	0.8638**	0.6043	2.3562	0.1073
	(0.411)	(0.382)	(0.634)	(0.448)	(0.339)	(0.441)	(1.649)	(0.358)
Time to water source	0.0034	0.0032	0.0108	-0.0007	0.0001	0.0035	0.0405	-0.0079
	(0.008)	(0.007)	(0.013)	(0.007)	(0.005)	(0.009)	(0.040)	(0.006)
Roads	0.0539***	0.0588***	0.0628***	0.0576***	0.0601***	0.0629***	0.0162	0.0444***
	(0.014)	(0.015)	(0.018)	(0.015)	(0.013)	(0.018)	(0.043)	(0.013)
Education	0.9876***	0.3804*	1.1070***	0.9056***	0.7133***	1.6877***	2.4840*	1.1459***
	(0.269)	(0.206)	(0.372)	(0.262)	(0.198)	(0.501)	(1.482)	(0.307)
Conflict	-0.0838**	-0.0332	-0.0931**	-0.0448	-0.0930***	-0.2597***	-0.2003**	-0.0505
	(0.035)	(0.040)	(0.039)	(0.050)	(0.027)	(0.070)	(0.099)	(0.046)
Religious fractionalization	0.2466	-0.7242**	0.7263	-0.1368	0.1845	-0.2375	1.9486	-0.3217
	(0.324)	(0.340)	(0.524)	(0.329)	(0.284)	(0.452)	(1.464)	(0.353)
Neighbors' nighlight per capita	0.2124*	0.3192***	0.1065	0.1976	0.2255*	0.1060	-0.1530	0.3598***
	(0.126)	(0.117)	(0.171)	(0.130)	(0.115)	(0.174)	(0.389)	(0.132)
Constant	-0.4474	-0.6614	-1.0907	-0.0750	-0.5861	-1.0263*	-1.0223	0.4026
	(0.482)	(0.468)	(0.765)	(0.461)	(0.382)	(0.623)	(1.543)	(0.429)
First stage								
Neighbors' domestic violence	0.7072***	1.1366***	0.3862***	1.1507***	0.8829***	0.4028***	0.3284*	0.7053***
	(0.106)	(0.138)	(0.095)	(0.192)	(0.110)	(0.109)	(0.188)	(0.126)
Observations	337	318	337	337	337	337	337	327
R-squared	0.632	0.684	0.376	0.619	0.717	0.271	0.414	0.620
F-test, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	51.16	68.09	16.49	52.46	77.82	15.91	3.42	42.07
Kleibergen-Paap rk LM statistic	24.93	36.77	12.75	21.35	29.30	10.52	3.01	22.28
Anderson-Rubin Wald test	49.87	40.86	49.87	49.87	49.87	49.87	49.87	48.96
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

D. Nonlinear effects

We now check for non-linearities in the effect of domestic violence on nightlights per capita. We explore the role of the law governing domestic violence in the country, the endowments in natural resources and the economic conditions.

Effects of law on domestic violence

The presence of protective laws against domestic violence has proven to be effective in dealing with physical, psychological and emotional abuse. Laws can not only be beneficial to women seeking to address domestic violence in their relationships but can also help enhance their physical and psychological well-being. One study found that many women who obtain civil protective orders are more successful in preventing subsequent psychological and emotional abuse (Grau et al. 1984). Some countries are also adopting protective provisions to ensure that women's labor force participation is not affected by domestic violence. In this regard, we suspect that the economic impact of domestic violence would depend on whether or not there are laws against domestic violence in the country. To explore this assumption, we include an interaction variable between protective law against domestic violence and gender-based violence. . We use the data from the World Bank's Women, Business and the Law, and define a binary variable taking the value of 1 if the country has adopted protective laws against domestic violence at the time of the survey, and 0 otherwise. The results are reported in Table 8, column (1). We find that the coefficient associated with violence against women remains negative and significant, while the coefficient associated with the interaction variable is positive and significant at the 5 percent level. This result implies that the negative effect of gender-based violence on nightlights per capita is dampened in countries with legal provisions against domestic violence. Legal provisions can help reduce the occurrence of domestic violence by deterring abusive behavior and also provide women access to justice for violence-related cases (Dugan, 2002), which could enhance their well-being and boost their economic participation and contributions. As expected, the coefficient associated with protective laws against domestic violence itself is positive and significant at the 10 percent level.

Effects of natural resources

We test whether the economic impact of domestic violence depends on the endowment in natural resources. Previous studies have provided evidence that mining zones can be a very hostile climate for women in general (ILO, 2007). In fact, mine openings can trigger a structural shift in employment patterns in Africa, with women leaving the agricultural fields for informal service jobs around the mining sites (for instance as vendors) , or out of the labor force (Kotsadam et al., 2017). Ross (2008, 2012) emphasized that an increase in natural resources leads to less female employment given that the revenues tend to crowd out low-wage and export-oriented factories. Drawing on this shift in employment, the reduction in female economic power and their dependence on their partners, Kotsadam et al. (2017) concluded that natural resources can increase women's risk of being abused by their intimate partners. In such environment where women's dependency is high, domestic violence could be elevated, which could lead to a high adverse economic impact. To test this hypothesis, we use the data on mining sites data from the United States Geological Society (United States Geological Survey (USGS), 2014). The variable takes the value of 1 if there is a mining site in the district and 0 otherwise. We define an interaction variable between gender-based violence and mining site, and then run the estimates with this interaction variable being included. The results displayed in Table 8, column (2) show that the coefficients associated with both violence against women and the interaction variable are negative and significant at the 1 percent level. This

finding suggests that economic costs of domestic violence are higher in resources-rich districts than in non-resources-rich districts, and thus confirms our hypothesis. The loss of female economic power and the higher dependence of women on their partners in resources-rich countries make women more vulnerable, increasing the risk of domestic violence and the related economic costs.

Table 8: Non-linear effects

Dependent variable: nighttime light per capita					
VARIABLES	(1)	(2)	(3)	(4)	(5)
Violence against women	-7.3210***	-14.9031***	-9.4469***	-31.6915***	-20.9654**
	(2.604)	(3.395)	(1.547)	(5.884)	(7.863)
Violence *law	5.2341**				
	(2.424)				
Law	0.7963*				
	(0.480)				
Violence*natural resources		-10.3803***			
		(3.071)			
Natural resources		-1.4481***			
		(0.497)			
Violence*economic conditions			0.7044**		
			(0.224)		
Economic conditions			-0.0273		
			(0.087)		
Violence*decision power				44.9079***	
				(8.812)	
Decision power				7.0456***	
				(1.643)	
Violence*education gap					-21.3012*
					(12.495)
Education gap					-4.7622**
					(1.195)
Agriculture	-0.1180	0.1616	0.0417	0.0436	-0.1406
	(0.209)	(0.250)	(0.203)	(0.261)	(0.239)
Urban area	0.5708*	0.3398	0.3562	0.2835	0.8105***
	(0.303)	(0.339)	(0.311)	(0.311)	(0.288)
Time to water source	0.0030	0.0002	-0.0046	-0.0018	-0.0119***
	(0.006)	(0.008)	(0.005)	(0.005)	(0.004)
Roads	0.0512***	0.0617***	0.0473***	0.0028	0.0683***
	(0.013)	(0.016)	(0.014)	(0.018)	(0.017)
Education	0.6046**	0.7957***	0.6616***	1.2004***	0.2835
	(0.297)	(0.272)	(0.191)	(0.315)	(0.291)
Conflict	-0.0728**	-0.0905**	-0.0693**	-0.0937***	-0.1072***
	(0.035)	(0.041)	(0.033)	(0.024)	(0.028)
Religious fractionalization	0.3103	0.6289	0.2173	0.2694	-0.5366*
	(0.332)	(0.385)	(0.326)	(0.342)	(0.324)
Neighbors' nighlight per capita	0.2941**	0.3057**	0.2858***	0.3597**	0.2235**
	(0.120)	(0.133)	(0.110)	(0.147)	(0.108)
Constant	-0.3100	0.5240	-0.1097	2.7384***	-2.8206
	(0.406)	(0.537)	(0.420)	(0.823)	(1.881)
First stage					
Neighbors' domestic violence	0.7008***	0.4925***	0.8093***	0.2212***	0.1629**
	(0.128)	(0.110)	(0.102)	(0.033)	(0.070)
Observations	319	337	333	337	337
R-squared	0.759	0.584	0.687	0.582	0.802
F-test, p-value	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	22.03	40.04	69.84	30.70	3.89
Kleibergen-Paap rk LM statistic	18.18	18.61	41.20	29.66	9.16
Anderson-Rubin Wald test	10.82	59.21	44.28	58.92	18.29
District fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes

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

Effects of economic conditions

During the COVID-19 pandemic crisis, we have observed an increase in domestic violence around the world. This is not unprecedented, as previous studies have underscored that the Great Depression was also followed by a proliferation of intimate partner violence (Liker and Elder, 1983; Conger et al. 1990). Sharp economic downturns could increase abusive behavior in two ways (Schneider et al., 2016). First, the direct experience of job loss and material hardship increases abusive behavior. Men, who might otherwise have kept negative

behaviors in check, may buckle under the stress of challenging economic circumstances and engage in abusive behavior. Second, declining macroeconomic conditions increase abusive behavior by increasing uncertainty and fear among a broad segment of the population. We hypothesize that this increase of domestic violence during economic downturns may exacerbate the economic costs of domestic violence compared to normal times.

To explore this assumption, we constructed a commodity price index at the district level using the data on the main crops of each district from the IPUMS dataset. The commodities include gold, maize, rice, soybean, sugarcane, wheat, sunflower, groundnut and oil palm. We then used the price data from the United Nations Conference on Trade and Development dataset and followed the approach defined in Kinda et al. (2018) to construct the commodity price index. The difference in prices between the year prior to the survey and the survey year is used to build the index. Given the reliance of sub-Saharan African economies on natural resources, we believe that the change in economic conditions is mostly driven by the fluctuations of commodity prices (Kinda et al. 2018). When commodity prices decline, people feel the brunt as their incomes collapse. define an interaction variable between the commodity price index and gender-based violence. The results are reported in Table 8, columns (3). We observe that the coefficient associated with violence against women remains negative and strongly significant, while the coefficient associated with the interaction variable is positive and significant, suggesting that the economic costs of domestic violence are higher during bad times. This finding implies that the increase in domestic violence during this pandemic and poor economic conditions could have more detrimental effects on economic development of African countries.

Effects of decision-making power and gender gap in education

Finally, we explore the role of women's decision-making power and the education inequality between wives and husbands. Many researchers have described intimate partner violence as a result of unbalanced power and control, and women with limited decision-making power were found to be subject to more physical violence (Rahman, et al., 2013; Koenig et al., 2003). In fact, higher decision-making power could increase women's ability to escape domestic violence, scare away violent partners or, at least, lessen its intensity.

Regarding education, it has been shown as protective against abuse (Amegbor and Rosenberg, 2019; Garcia-Moreno et al., 2005). High educational attainment is negatively associated with being both a victim and a perpetrator of abuse (Cools and Kotsadam, 2017; Pierotti, 2013; Mocan and Cannonier, 2012; Jewkes, 2002). Pierotti (2013) argued that education affects behavior via identity and learning about the normative foundations of society, and it may expand horizons, as well as increase exposure to global discourses rejecting partner violence.

We investigate whether the level of decision-making power and closing the gender gap in education could help lessen the economic consequences of intimate partner violence. To measure the level of decision-making power, we rely on the IPUMS survey question about women's ability to take decisions about their healthcare. We construct an indicator measuring the percentage of women who are able to take their own decisions regarding healthcare needs. As for the gender gap in education, we measure the difference in the level of education between husbands and wives at the district level using the data from IPUMS dataset. We then define two interaction variables between each variable and violence against women. The results are reported in Table 8, columns 4 and 5. We find that the coefficients associated with domestic violence remain negative and highly significant in all 2 columns, while the coefficient associated with the interaction variable with decision-making

power is positive and the one with education inequality is negative and significant. Furthermore, the coefficients associated with the variables decision-making power and education gap are positive and negative, respectively. These results suggest that districts with low level of women's decision-making power and high level of gender gap in education tend to suffer most from domestic violence. As explained above, more decision-making power and equal level of education could make women less dependent on their partners, reducing the prospect of control and violence, and therefore the potential impact of domestic violence on the economy.

VII. Robustness checks

A. Use of alternative definition of violence: controls and beliefs

We use some variables related to women's attitudes toward intimate partner violence. We rely on some questions in the IPUMS dataset asking women whether a husband is justified in beating his wife in various hypothetical situations, including for any reasons, arguing with the husband, woman burns food, woman goes out without telling him, woman refused to have sex and woman neglects the children. As Bobonis, Gonzalez-Brenes, and Castro (2013) emphasized, women's attitudes toward domestic violence are shaped by their own experiences of domestic violence or social norms inherited from the local communities. Several papers have used these variables in previous studies (La Mattina, 2017; Pierotti, 2013, Yount and Li, 2009). We estimate equation (1) using the instrumental variable method, with each of these variables related to attitudes toward intimate partner violence in a given district being instrumented with the average in neighboring districts. The results are reported in Table 9. We find that the coefficient associated with the variable *attitudes toward violence* is negative and strongly significant at the 1 percent level in all columns. This result implies that an environment and culture of acceptance of violence are associated with lower economic development proxied by nightlights per capita.

Table 9: Robustness check: controls and beliefs towards violence

Dependent variable: nighttime light per capita						
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Beating is justified for any reasons	Beating is justified if woman argues with him	Beating is justified if woman burns food	Beating is justified if woman goes out without telling him	Beating is justified if woman refused to have sex	Beating is justified if woman neglects the children
Attitudes towards violence	-3.8205***	-4.8672***	-13.1854***	-4.4833***	-4.4507***	-3.4961***
	(0.762)	(0.863)	(4.166)	(0.801)	(0.736)	(0.590)
Agriculture	-0.5253*	-0.1785	-0.2142	-0.2751	-0.1763	-0.2138
	(0.284)	(0.236)	(0.434)	(0.227)	(0.220)	(0.205)
Urban area	0.5148	0.9215***	0.2479	0.6474**	0.4305	0.4447
	(0.319)	(0.320)	(0.561)	(0.302)	(0.306)	(0.278)
Time to water source	-0.0065	0.0028	0.0155	-0.0025	-0.0032	-0.0032
	(0.006)	(0.006)	(0.014)	(0.005)	(0.005)	(0.005)
Roads	0.0649***	0.0649***	0.0400*	0.0719***	0.0562***	0.0710***
	(0.013)	(0.015)	(0.022)	(0.015)	(0.014)	(0.014)
Education	-0.2398	-0.6464***	-0.7146*	-0.4812**	-0.5028**	-0.1015
	(0.185)	(0.216)	(0.419)	(0.203)	(0.197)	(0.163)
Conflict	0.0218	-0.0413	-0.0150	-0.0002	0.0356	0.0074
	(0.055)	(0.030)	(0.045)	(0.042)	(0.049)	(0.044)
Religious fractionalization	-0.1184	0.3524	-0.2252	0.2083	-0.1885	0.1397
	(0.366)	(0.415)	(0.725)	(0.351)	(0.345)	(0.327)
Neighbors' nighlight per capita	0.2863***	0.2246**	0.4243***	0.2812***	0.3738***	0.3488***
	(0.103)	(0.089)	(0.151)	(0.087)	(0.088)	(0.086)
Constant	1.8601***	1.3944***	2.8792**	1.5364***	1.8122***	1.0699***
	(0.524)	(0.481)	(1.156)	(0.471)	(0.460)	(0.389)
First stage						
Neighbors' domestic violence	2.0108***	1.5784***	0.5826***	1.7135***	1.7261***	2.1975***
	(0.344)	(0.248)	(0.185)	(0.249)	(0.206)	(0.267)
Observations	337	337	337	337	337	337
R-squared	0.574	0.638	-0.011	0.652	0.681	0.680
F-test, p-value	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	47.16	55.35	15.05	68.26	87.05	92.32
Kleibergen-Paap rk LM statistic	28.11	33.19	10.36	39.5	50.52	47.76
Anderson-Rubin Wald test	61.02	61.02	61.02	61.02	61.02	61.02
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

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

B. Using an alternative instrumental variable

As in Cherif et al. (2018), we use the median of the level of intimate partner violence against women in neighboring districts as instrumental variable, instead of the simple averages. The weights are inversely proportional to the level of development of the neighboring districts measured by nightlight per capita, thus helping to ensure that big neighbors are not overweighed. The results obtained using this instrumental variable are reported in Table 10. As can be observed, our results still hold despite the change in the measurement of the instrumental variable.

Table 10: Robustness check: Using the median of neighbor's violence as instrumental variable

Dependent variable: nighttime light per capita								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Composite index	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner
Violence against women	-8.9645***	-6.0086***	-14.9336***	-5.3470***	-8.1511***	-17.4683***	-13.7012***	-8.8031***
	(1.324)	(0.993)	(2.934)	(0.846)	(1.069)	(3.865)	(4.264)	(1.470)
Agriculture	0.1506	0.1864	0.4028	0.2833	-0.0134	-0.2233	0.2674	0.1189
	(0.223)	(0.212)	(0.315)	(0.221)	(0.211)	(0.344)	(0.452)	(0.223)
Urban area	0.5015	0.6932**	0.5263	0.5203	0.7629***	0.5783	0.7121	-0.3087
	(0.311)	(0.321)	(0.408)	(0.327)	(0.277)	(0.392)	(0.555)	(0.328)
Time to water source	0.0020	0.0024	0.0066	-0.0016	-0.0000	0.0028	0.0218	-0.0076
	(0.006)	(0.006)	(0.009)	(0.006)	(0.005)	(0.008)	(0.018)	(0.005)
Roads	0.0540***	0.0586***	0.0613***	0.0571***	0.0600***	0.0627***	0.0313	0.0460***
	(0.014)	(0.015)	(0.016)	(0.014)	(0.013)	(0.017)	(0.025)	(0.012)
Education	0.8458***	0.3435*	0.8715***	0.7499***	0.6937***	1.6168***	1.5135**	0.9594***
	(0.228)	(0.193)	(0.278)	(0.214)	(0.191)	(0.426)	(0.601)	(0.241)
Conflict	-0.0838**	-0.0376	-0.0910***	-0.0513	-0.0928***	-0.2517***	-0.1548***	-0.0555
	(0.034)	(0.038)	(0.034)	(0.046)	(0.027)	(0.063)	(0.058)	(0.043)
Religious fractionalization	0.3283	-0.7458**	0.6771	0.0354	0.2137	-0.2342	-1.4655*	-0.1083
	(0.324)	(0.339)	(0.443)	(0.315)	(0.282)	(0.419)	(0.815)	(0.338)
Neighbors' nighlight per capita	0.2493**	0.3323***	0.1794	0.2450**	0.2329**	0.1180	0.0872	0.3812***
	(0.117)	(0.114)	(0.139)	(0.119)	(0.113)	(0.164)	(0.185)	(0.124)
Constant	-0.5196	-0.6906	-1.0065	-0.2314	-0.6059	-0.9879*	-0.9620	0.1707
	(0.462)	(0.456)	(0.638)	(0.439)	(0.383)	(0.595)	(1.022)	(0.407)
First stage								
Neighbors' domestic violence	0.9212***	1.4024***	0.5530***	1.5445***	1.0131***	0.4727***	0.6027***	0.9373***
	(0.113)	(0.149)	(0.099)	(0.201)	(0.109)	(0.111)	(0.190)	(0.139)
Observations	337	318	337	337	337	337	337	327
R-squared	0.675	0.704	0.412	0.669	0.722	0.323	-0.308	0.671
F-test, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	82.61	103.19	33.91	85.82	103.43	13.11	11.33	68.30
Kleibergen-Paap rk LM statistic	36.48	54.21	21.96	34.78	37.00	22.69	9.60	31.52
Anderson-Rubin Wald test	66.00	54.41	66.00	66.00	66.00	66.00	66.00	65.74
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

C. Excluding outliers

Finally, we check the robustness of our results by excluding the outliers from the estimates. The outliers are defined as the top 5 percent and the bottom 5 percent of the occurrence of domestic violence. The test is to check whether these outliers lead to over-estimate or under-estimate of the effects of domestic violence on nightlights per capita in the range where most of our observations are located. Table 11 reports the effect of intimate partner violence against women after excluding the outliers. Our results remain similar with the findings reported in Table 4, as the coefficient associated with domestic violence against women is negative and strongly significant at the 1 percent level. This suggests that findings are robust to the omission of outliers from the sample. However, the coefficients associated with domestic violence against women are larger in Table 11 than in the baseline Table 5.

Table 11: Robustness check: Excluding outliers

Dependent variable: nighttime light per capita								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	Composite index	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner
Violence against women	-9.0503***	-6.0299***	-15.8982***	-5.1223***	-8.3159***	-20.7015***	-14.4731***	-8.5956***
	(1.389)	(0.970)	(3.408)	(0.835)	(1.139)	(5.339)	(4.710)	(1.469)
Agriculture	0.1951	0.2370	0.4975	0.2961	0.0206	-0.2121	0.3955	0.1398
	(0.222)	(0.206)	(0.335)	(0.219)	(0.211)	(0.400)	(0.472)	(0.222)
Urban area	0.4570	0.6261**	0.4458	0.5045	0.7296***	0.5296	0.5564	-0.2601
	(0.307)	(0.312)	(0.406)	(0.317)	(0.274)	(0.436)	(0.555)	(0.325)
Time to water source	-0.0010	-0.0010	0.0032	-0.0039	-0.0024	0.0014	0.0150	-0.0083
	(0.006)	(0.005)	(0.008)	(0.006)	(0.005)	(0.009)	(0.017)	(0.005)
Roads	0.0553***	0.0597***	0.0634***	0.0596***	0.0610***	0.0617***	0.0313	0.0468***
	(0.014)	(0.015)	(0.016)	(0.014)	(0.013)	(0.019)	(0.026)	(0.012)
Education	0.8073***	0.2956	0.8596***	0.6784***	0.6659***	1.8416***	1.5014**	0.9156***
	(0.226)	(0.188)	(0.292)	(0.206)	(0.191)	(0.536)	(0.627)	(0.241)
Conflict	-0.0864***	-0.0394	-0.0959***	-0.0545	-0.0951***	-0.2857***	-0.1652***	-0.0572
	(0.033)	(0.037)	(0.036)	(0.044)	(0.026)	(0.080)	(0.062)	(0.043)
Religious fractionalization	0.2659	0.6832**	0.6309	-0.0011	0.1670	-0.3729	1.3933*	-0.1617
	(0.324)	(0.340)	(0.460)	(0.312)	(0.284)	(0.475)	(0.833)	(0.339)
Neighbors' nighlight per capita	0.2499**	0.3409***	0.1704	0.2494**	0.2319**	0.0690	0.0881	0.3717***
	(0.118)	(0.113)	(0.145)	(0.118)	(0.113)	(0.185)	(0.193)	(0.124)
Constant	-0.3176	-0.4639	-0.7708	-0.0663	-0.4434	-0.9162	-0.5047	0.2348
	(0.443)	(0.418)	(0.621)	(0.411)	(0.368)	(0.686)	(1.007)	(0.408)
First stage								
Neighbors' domestic violence	0.8441***	1.3163***	0.4805***	1.4915***	0.9187***	0.3690***	0.5278***	0.8861***
	(0.103)	(0.132)	(0.093)	(0.189)	(0.100)	(0.102)	(0.175)	(0.126)
Observations	331	314	331	331	331	331	331	321
R-squared	0.686	0.721	0.406	0.692	0.727	0.183		0.683
F-test, p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cragg-Donald Wald F statistic	84.29	118.50	31.04	94.41	102.24	17.18	10.39	73.29
Kleibergen-Paap rk LM statistic	38.14	56.45	20.60	37.69	39.51	10.41	8.79	33.74
Anderson-Rubin Wald test	58.04	52.83	58.04	58.04	58.04	58.04	58.04	57.71
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

D. Adding more covariates

We finally test different specifications and include additional covariates to our baseline estimates. In columns (1) and (2) of Table 12, we replace the share of individuals living in urban area with the density of the population, and the share of cropland in total area by precipitations, respectively. In column (3), we include a wealth index, which is a composite measure of a household's cumulative living standard based on selected assets, including televisions and bicycles, materials used for housing construction, and types of water access and sanitation facilities. In column (4), we control for a proxy measure of the income gap between husbands and wives, and in column (5) a binary variable taking the value of 1 if there is an oil site in the district and 0 otherwise. Regarding the proxy indicator of the income gap, we rely on a survey question asking about whether or not the respondent's earnings are higher than the earnings of her partner, and we calculate the share of women with equal or higher earnings than their husbands. To capture the role of the financial sector, we include the share of individuals who have a bank account in column (6), while in column (7), we control for the access to electricity, which is another

key indicator of availability of infrastructure. For the estimates, we use the composite index of intimate partner violence against women. As reported in Table 12, we still find that the coefficients associated with domestic violence against women remain negative and highly significant in all columns. Therefore, our results are robust to the inclusion of additional variables. Table 12 also shows that the coefficient associated with access to banks is positive and strongly significant at the 1 percent level, suggesting that access to banking services could boost economic opportunities (Levine, 1997). Furthermore, the coefficient associated with income gap is negative and slightly significant at the 10 percent level, in line with previous studies about the adverse effect of income inequality on economic growth (Ostry et al. 2014; Brueckner and Lederman, 2015). The remaining additional variables are not statistically significant.

Table 12: Robustness check: adding more covariates

Dependent variable: nighttime light per capita							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Violence against women	-9.1982***	-9.9986***	-8.6700***	-9.1916***	-8.7912***	-2.9886***	-7.9532***
	(1.382)	(1.796)	(1.282)	(1.698)	(1.290)	(1.146)	(1.483)
Agriculture	0.1293		0.1481	0.1933	0.1720	-0.0010	0.2017
	(0.231)		(0.219)	(0.279)	(0.222)	(0.182)	(0.219)
Urban area		0.4837	0.5532	0.4680	0.5130*	0.0195	-0.0664
		(0.326)	(0.338)	(0.333)	(0.307)	(0.294)	(0.554)
Time to water source	0.0003	0.0033	0.0013	0.0063	0.0012	0.0000	0.0026
	(0.007)	(0.007)	(0.006)	(0.008)	(0.006)	(0.004)	(0.006)
Roads	0.0504***	0.0498***	0.0544***	0.0634***	0.0458***	0.0734***	0.0531***
	(0.014)	(0.013)	(0.014)	(0.015)	(0.014)	(0.014)	(0.013)
Education	0.8822***	0.9190***	0.8308***	0.9568***	0.7466***	0.4149***	0.6898***
	(0.227)	(0.265)	(0.222)	(0.273)	(0.225)	(0.157)	(0.236)
Conflict	-0.0679**	-0.0986***	-0.0839**	-0.0899**	-0.0789**	-0.0521	-0.0723**
	(0.029)	(0.033)	(0.033)	(0.036)	(0.034)	(0.033)	(0.034)
Religious fractionalization	0.2486	0.2292	0.3003	-0.8138**	0.3229	-0.6166**	0.2557
	(0.322)	(0.336)	(0.321)	(0.372)	(0.316)	(0.284)	(0.320)
Neighbors' nighlight per capita	0.3100***	0.2447*	0.2472**	0.2745**	0.2519**	0.3085***	0.2608**
	(0.107)	(0.127)	(0.119)	(0.128)	(0.111)	(0.110)	(0.111)
Population density, Log	0.0494						
	(0.046)						
Precipitations		0.2987					
		(0.257)					
Wealth index			-0.0177				
			(0.053)				
Income gap				-0.8601*			
				(0.515)			
Oil field					0.3232		
					(0.251)		
Access to banks						1.7419***	
						(0.364)	
Access to electricity							0.7857
							(0.541)
Constant	-0.5616	-1.9621	-0.5190	-0.7629	-0.3803	-0.4946*	-0.4298
	(0.493)	(1.476)	(0.455)	(0.532)	(0.471)	(0.293)	(0.442)
First stage							
Neighbors' domestic violence	0.8840***	0.8082***	0.8821***	0.8909***	0.8878***	0.9837***	0.8186***
	(109)	(0.105)	(0.107)	(0.133)	(0.106)	(0.133)	(0.108)
Observations	337	337	337	280	337	288	337
R-squared	0.666	0.641	0.685	0.680	0.684	0.847	0.711
F-test, p-value	0	0	0	0	0	0	0
Cragg-Donald Wald F statistic	85.95	58.03	87.05	61.25	88.7	63.16	69.8
Kleibergen-Paap rk LM statistic	36.32	33.26	37.64	29.04	38.64	35.72	40.65
Anderson-Rubin Wald test	60.29	47.97	60.01	42.76	64.82	7.42	50.85
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

VIII. Conclusion

In this paper, we empirically explore the economic cost of several types of violence against women in sub-Saharan Africa. We overcome various data challenges highlighted in previous studies using a large set of 29 demographic surveys data extracted from the IPUMS website. Our sample covers 224 districts from 18 sub-Saharan African countries, representative of nearly 75 percent of the women population in the continent. Relying on a two-stage least square method to address endogeneity, we identify the causal effect of violence against women on economic activities. We also explore the channel of transmission and look at whether there are some heterogeneities in the effect of violence against women on economic development.

We find that higher levels of VAWG are associated with lower economic development. Our results suggest that an increase in violence against women by 1 percentage point can reduce nightlights-based economic activities by up to 8.7 percent on average. We also find strong evidence that this adverse effect is driven by the negative impact of VAWG on the labor supply of victims. Furthermore, our results show that the negative economic effect of violence against women is higher in countries without protective laws against domestic violence, natural resource-rich countries, where women are deprived of decision-making power and during economic downturns. A significant gender gap in education also contributes to higher adverse effect of violence against women. Our findings are robust to several specifications, including using an alternative instrumental variable, an alternative beliefs-based definition of violence against women, excluding outliers and including several additional covariates.

The paper has several policy implications. First, the findings imply that adopting and reinforcing laws against domestic violence and strengthening women's decision-making power could help lower violence and the economic cost of domestic violence. As evidenced in previous studies, strong laws are crucial to deter violence against women, protect victims of domestic violence and promote women's participation in the labor markets. Second, the results highlight that sub-Saharan African countries should encourage girls' education in order to reduce the gender gap in education and therefore, attenuate the influence and control by men. Third, sub-Saharan African countries should pay attention to the increased levels of domestic violence during the COVID-19 pandemic. As the results show, the economic cost of violence against women is higher during downturns, suggesting that the economic recovery from the current crisis could take longer if domestic violence is not tackled. Finally, sub-Saharan African governments should implement targeted policies to ensure that the windfalls from the exploitation of natural resources are not used to dominate and control women.

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Appendices

Table A 1: List of country surveys

Country	Survey year	Number of districts	Number of individuals
Angola	2015	14	14,379
Burundi	2016	17	17,269
Cameroon	2004	10	10,656
Cameroon	2011	11	15,426
Democratic Republic of Congo	2007	9	9,995
Democratic Republic of Congo	2013	9	18,827
Ethiopia	2016	11	15,683
Ghana	2008	12	4,916
Kenya	2003	11	8,195
Kenya	2008	11	8,444
Kenya	2014	11	31,079
Malawi	2010	28	23,020
Malawi	2016	27	24,562
Mali	2006	8	14,583
Mali	2012	6	10,424
Mozambique	2011	10	13,745
Namibia	2013	12	10,018
Nigeria	2008	5	33,385
Nigeria	2013	5	38,948
Senegal	2017	14	16,787
South Africa	2016	7	8,514
Zimbabwe	2005	10	8,907
Zimbabwe	2010	10	9,171
Zimbabwe	2015	10	9,955
Tanzania	2010	24	10,139
Tanzania	2015	27	13,266
Burkina Faso	2010	13	17,087
Zambia	2007	8	7,146
Zambia	2013	8	16,411
Total		224	440,937

Table A 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Nightlights per capita, log	358	1.10	1.22	0.00	5.77
Non-agriculture employment	358	0.51	0.27	0.04	1.00
Violence against women, composite index	358	0.17	0.08	0.02	0.46
Any physical results of husband's actions	339	0.13	0.10	0.01	0.70
Spouse ever punched with fist or something harmful	351	0.12	0.06	0.01	0.42
Spouse ever slapped	351	0.26	0.12	0.01	0.63
Spouse ever pushed, shook, or threw something	358	0.13	0.08	0.00	0.46
Spouse ever threatened with harm	358	0.11	0.07	0.01	0.54
Spouse ever experienced any emotional violence	358	0.27	0.12	0.03	0.80
Spouse ever experienced any sexual violence from partner	348	0.13	0.09	0.00	0.47
Beating is justified for any reasons	358	0.44	0.23	0.03	0.88
Beating is justified if woman argues with him	358	0.28	0.18	0.01	0.77
Beating is justified if woman burns food	358	0.15	0.12	0.01	0.56
Beating is justified if woman goes out without telling him	358	0.29	0.18	0.01	0.73
Beating is justified if woman refused to have sex	358	0.24	0.17	0.00	0.72
Beating is justified if woman neglects the children	358	0.32	0.19	0.02	0.80
Agriculture	337	0.34	0.22	0.00	0.73
Urban area	358	0.34	0.23	0.04	1.00
Time to water source	358	23.60	12.82	0.16	78.18
Roads, log	358	2.36	5.40	0.00	18.64
Education, log	358	1.88	0.44	0.47	2.56
Conflict	358	0.05	0.51	0.00	9.26
Religious fractionalization	358	0.61	0.25	0.01	1.00
Violence against men	349	0.04	0.03	0.00	0.23
Neighbors' domestic violence	358	0.16	0.05	0.06	0.33

Table A 3: Baseline results using OLS, disaggregating violence against women

Dependent variable: nighttime light per capita							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Any physical results of husband's actions	Spouse ever punched with fist or something harmful	Spouse ever slapped	Spouse ever pushed, shook, or threw something	Spouse ever threatened with harm	Spouse ever experienced any emotional violence	Spouse ever experienced any sexual violence from partner
Violence against women	-1.1905**	-1.1746*	-1.1980***	-2.7919***	-2.4185***	-0.6882**	-2.1538***
	(0.493)	(0.673)	(0.414)	(0.606)	(0.604)	(0.340)	(0.627)
Agriculture	0.1529	0.2271	0.2344	0.1453	0.1523	0.2133	0.2136
	(0.204)	(0.204)	(0.198)	(0.191)	(0.202)	(0.207)	(0.202)
Urban area	1.1785***	1.1282***	1.0939***	1.1374***	1.1009***	1.1415***	0.9274***
	(0.229)	(0.228)	(0.223)	(0.218)	(0.225)	(0.231)	(0.229)
Time to water source	-0.0079**	-0.0108***	-0.0097***	-0.0077**	-0.0102***	-0.0106***	-0.0109***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.003)
Roads	0.0636***	0.0608***	0.0603***	0.0611***	0.0611***	0.0592***	0.0588***
	(0.015)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)
Education	0.2873*	0.2930*	0.3659**	0.4121***	0.4344***	0.3053*	0.4511***
	(0.163)	(0.152)	(0.148)	(0.151)	(0.167)	(0.159)	(0.163)
Conflict	-0.1085***	-0.1153***	-0.1067***	-0.1157***	-0.1363***	-0.1183***	-0.1113***
	(0.028)	(0.025)	(0.029)	(0.026)	(0.024)	(0.026)	(0.029)
Religious fractionalization	-0.0834	-0.3708	-0.3495	-0.2299	-0.4290	-0.3635	-0.3687
	(0.346)	(0.328)	(0.315)	(0.298)	(0.303)	(0.324)	(0.304)
Constant	-0.4550	-1.6239***	-1.5570***	-1.5601***	-1.6982***	-1.5826***	-1.7114***
	(0.471)	(0.476)	(0.480)	(0.473)	(0.486)	(0.494)	(0.473)
Observations	318	337	337	337	337	337	327
R-squared	0.789	0.774	0.781	0.791	0.783	0.774	0.789
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

PUBLICATIONS

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