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Patrick Hufschmidt and Chukwuma Ume[1]

Conflicts and Political Intervention: Evidence from the Anti-Open Grazing Laws in Nigeria

Abstract

This paper empirically investigates the effects of Anti-Open Grazing Laws (AOGLs) on herder-farmer conflicts in Nigeria. The laws, enacted as a response to escalating violent conflicts over fertile land resources between herders and farmers, aimed to reduce clashes by prohibiting livestock grazing in specific areas and periods. Our study employs a geographic difference-in-discontinuities design, leveraging the sharp change in legal conditions at state borders and the panel structure of our data. We integrate conflict data from the Armed Conflict Location & Event Data Project (ACLED) with spatially disaggregated microdata to analyze how AOGLs influence conflict incidence across regions of Nigeria. Our findings indicate limited effectiveness of AOGLs in curbing herder-farmer conflicts, suggesting instead a displacement of conflicts. It also appears that the laws have led to a slight increase in overall conflict within the states implementing them, arguably due to increased engagements between herder or farmer groups and security forces. These results underscore the need for more comprehensive, context-specific interventions to address the root causes of herder-farmer conflicts.

JEL-Code: D74, N47, Q13, Q34

Keywords: Conflict; civil war; climate change; ethnicity; resource competition; herder-farmer conflicts

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1 Patrick Hufschmidt, Ruhr University Bochum; Chukwuma Ume, University of Nigeria. *– We gratefully acknowledge financial support from the German Research Foundation (DFG) within the Project "Regional Favoritism and Development" (Grant no. 423358188 / BA 496716-1). The usual disclaimer applies.* *– All correspondence to: Patrick Hufschmidt, Ruhr University Bochum, Universitätsstr. 150, 44801 Bochum, Germany, e-mail: patrick.hufschmidt@rub.de*

1 Introduction

Livestock production by pastoralists plays a pivotal role in the economies and livelihoods of Africa's semi-arid areas. This practice, which originated around seven millennia ago in response to long-term climatic shifts, proliferated across Northern Africa as a strategy to cope with the increasingly unpredictable arid climate. Today, it is practiced across 43% of Africa's total land area, across diverse regions, and in certain areas, it's the predominant livelihood system. Spanning 36 countries from the Sahelian West to the rangelands of Eastern Africa, the Horn, and even the nomadic communities of Southern Africa, it is estimated that around 268 million pastoralists (around one fifth of the African population) engage in this form of agriculture (FAO, 2018; Konczacki, 2014).

In Africa, approximately 65–70% of the workforce is employed in agriculture. This sector not only supports the livelihoods of 90% of Africa's population but also contributes about a quarter of the continent's GDP (Mukasa et al., 2017; OECD and Food and Agriculture Organization of the United Nations, 2016; World Bank, 2016). These figures show that farming is even more prevalent than pastoralism across the continent, although these two activities often overlap and are not mutually exclusive. In particular, the two practices often exist in harmony, with many communities practicing a combination of the two, known as agro-pastoralism.

In recent years, however, conflicts involving pastoralist groups and farmers – known as herder-farmer conflicts – have increasingly posed complex and severe socio-economic challenges to many African countries. These armed conflicts, primarily driven by competing interests over scarce resources such as land and water, have begun to significantly impact not only the livelihoods of the individuals directly involved, but also the broader economic stability of the regions where they occur.

While previous literature mainly identifies climate change as a crucial factor in the escalation of agro-pastoral conflicts (McGuirk and Burke, 2020; Eberle et al., 2020), there is limited knowledge about the impacts of political measures intended to address these conflicts over increasingly scarce land resources. Several strategies have been suggested to mitigate herder-farmer conflicts. These include agricultural development policies, particularly the transformation of pastoral practices to ranching (e.g., see McGuirk and Nunn (2023)), specific land use planning and policies, taxation, enforcement of property rights, community-based management systems, and specialized grazing laws.

Grazing laws have been implemented by several Nigerian states in response to escalating violent conflicts between cattle herders and crop farmers in the country. Specifically, starting in 2016, 13 Nigerian states (Ekiti, Edo, Benue, Taraba, Abia, Bayelsa, Rivers, Ondo, Lagos, Delta, Enugu, Osun, Ogun) enacted what are known as "Anti-Open Grazing Laws" (AOGLs), commonly referred to as "grazing bans". These laws aim to reduce clashes over fertile land resources by prohibiting livestock from grazing in certain areas, particularly during specified periods, to allow for the regeneration of grassland or prevent damage to crops. While grazing bans may be effective in certain circumstances, they should be implemented with careful consideration of their potential impacts. For instance, these bans can exert significant pressure on herders by limiting their access to pastures, forcing them to move their livestock to other areas. This displacement could potentially lead to additional conflicts or degrade these new regions due to overuse.

Moreover, enforcing grazing bans can be challenging as it requires resources for monitoring and compliance, as well as cooperation from local communities. Therefore, involving local communities, including both farmers and herders, in decision-making processes related to the implementation of grazing bans is crucial. Considering that Nigeria is confronted with ongoing crises and weak institutions concerning the rule of law, as evidenced by its low rank in the Rule of Law Index (rank 118 out of 140 in 2022) (World Justice Project, 2023), the effectiveness of AOGLs in achieving their intended outcomes remains questionable.

This paper illuminates the broader spatial implications of political interventions aimed at resolving resource conflicts. Specifically, we investigate how AOGLs might influence the incidence of conflicts across various regions of Nigeria by integrating conflict data with spatially disaggregated microdata, which includes a range of covariates.[1] Particularly, we utilize geo-referenced conflict data retrieved from the Armed Conflict Location & Event Data Project (ACLED) as an outcome variable (Raleigh et al., 2010).[2] Our study focuses on how the implementation of AOGLs affects conflicts in the regions of law-enacting states, neighboring states, and all other states.

In Nigeria, disputes over arable land resources often involve Muslim Fulani herders, who make up around 90% of the country's pastoralists, and non-Fulani farmer groups, who are predominantly Christian. Consequently, conflicts in this context are often attributed to religious and ethnic dimensions. Herder-farmer conflicts have been particularly prevalent in the Middle Belt region, where battles between herders and farmers have become increasingly frequent. For instance, during the first half of 2018 alone, it is estimated that over 1,300 Nigerians lost their lives in such conflicts. What initially started as spontaneous attacks has now evolved into premeditated and devastating campaigns, with raiders frequently catching villages off-guard in nighttime assaults. As of 2018, this conflict was estimated to claim six times more civilian lives than the Boko Haram insurgency, posing a significant security threat to Nigeria (Crisis Group, 2018).

Despite the federal government's implementation of certain measures to address the growing herder-farmer conflicts, such as the deployment of additional police or military forces in affected regions, these efforts seem to be insufficient. The escalation of violence has resulted in significant displacements of people. Moreover, the ongoing violence places a heavy burden on the military, police, and other security services, diverting their attention from other critical tasks such as combating the Boko Haram insurgency (Crisis Group, 2018).[3]

Given the high diversity in natural endowments, population, and religion within Nigeria, it becomes empirically challenging to isolate the potential effects of AOGLs. For instance, conducting a simple comparison between treated states (AOGL-implementing states) and non-treated states may be subject to unobserved confounders.

[1] We employ a grid primarily composed of 0.1×0.1 degree cells, while using smaller cut-off cells at the borders. The following approximation remains accurate for any latitude and for longitude at the equator: $0.1° = 11.1$ km

[2] Source: acleddata.com

[3] Furthermore, a study conducted by the World Bank (World Bank, 2018), covering the years 2010-2017, reveals that conflicts related to land or resource access constitute the largest reported category of conflicts affecting households (55%) in the North Central geopolitical zone of Nigeria, which encompasses most of the Middle Belt. This is followed by terrorism, accounting for 21% of total conflicts, and cultism and criminality, accounting for 16%.

Our empirical design addresses this issue by leveraging the sharp change in legal conditions at the borders of treated states and the panel structure of our sample. Specifically, we employ a geographic difference-in-discontinuities design (Butts, 2021; Wuepper and Finger, 2023). This design overcomes several challenges that would typically make it implausible to compute the differences in outcomes across states. For instance, pre-existing disparities in state institutions or natural resources may lead to differential trends in conflict occurrence. While there are diverging trends observed in both the treated and control states as a whole, our event studies demonstrate that these trends diminish when comparing areas on both sides of the borders that are proximate or similar in size. Assuming that both sides of the border within a certain distance are similar in all relevant aspects that may influence herder-farmer conflicts, apart from the treatment itself, enables us to plausibly isolate the treatment effect.

In fact, our summary statistics indicate that observed factors at the grid level, such as night light intensity, precipitation rates, vegetation, population numbers, the party affiliation of the state governor, and various crucial distances (to police stations, security forces, water bodies, churches, and mosques), exhibit high similarity within a radial buffer of 50 km around the borders of treated states. Furthermore, even when employing a bandwidth of up to 200 km instead of the entire sample of cells, the similarity remains significantly higher. This is because the total sample includes the Sahel area, whereas the samples from 25 km up to a 200 km bandwidth pertain to Southern Nigeria and the Middle Belt region of the country.

The aforementioned variables and the panel structure further assist us in mitigating unobserved heterogeneity. Specifically, we incorporate cell fixed effects into our model. Unobserved variables that may potentially influence herder-farmer conflicts in each area could encompass cultural norms, historical events, or geographical features. By including cell fixed effects in the model, we account for time-invariant variables that vary between cells but remain constant over time. Additionally, we include time fixed effects to control for time-varying factors that remain constant across cells, such as national policy changes, climate developments, or economic fluctuations.

As AOGLs have been implemented by different states in different years, the empirical setting presents challenges regarding treatment effect heterogeneity. Therefore, we address recent econometric concerns related to staggered difference-in-differences research designs by adopting the methodology proposed by Sun and Abraham (2021), which specifically tackles these difficulties.

By employing various iterations of difference-in-differences and differences-in-discontinuities designs at the grid-level, our analysis reveals robust evidence suggesting that AOGLs have limited effectiveness in reducing herder-farmer conflicts. Our findings, covering the period from 2010 to 2022, highlight several important insights.

First, the overall evidence indicates that these laws have likely led to a shifting of conflicts towards the border regions of neighboring states that did not enact similar legislation. This suggests a displacement effect rather than a substantial reduction in conflicts.

Second, the magnitude of our estimates suggests that the intended effect of significantly reducing herder-farmer conflicts in the states that implemented AOGLs has not materialized. Although we do observe a reduction in conflict spread and battles in treated states proximate to the state border, when considering the overall geographic extent of the treated states, the results indicate an overall increase in conflict numbers, particularly in the category of "battles."

Third, our analysis reveals an increase in engagements between herder or farmer associated groups and security forces subsequent to the implementation of AOGLs. While we do find a corresponding decrease in fatalities, it should be noted that the fatality variable exhibits high volatility, which reduces the robustness of this specific finding.

Finally, we find no systematic spillover effects on other conflict categories, suggesting that law enforcement efforts are primarily directed towards herder-farmer conflicts, rather than influencing the broader conflict landscape.

Overall, our results cast doubt on the effectiveness of AOGLs in reducing herder-farmer conflicts. These findings underscore the need for comprehensive and context-specific approaches to address the underlying causes of herder-farmer conflicts.

Yet, quantitative evidence regarding the impact of grazing restrictions on herder-farmer conflicts is still limited in the existing literature. As such, our findings not only contribute to a better understanding of the specific case of Nigeria but also provide valuable insights for policymakers considering similar measures in other regions or countries. Given that the implemented laws have thus far demonstrated limited or even adverse outcomes on herder-farmer conflicts, it is crucial to carefully design such institutions or engage in discussions about additional or alternative measures.

Furthermore, our study offers a methodological contribution by employing a difference-in-discontinuities design within conflict research. To the best of our knowledge, only one paper (Ackermann et al., 2021) has utilized such a design in the context of conflict research.

Our paper contributes primarily to a new line of research that specifically investigates herder-farmer conflicts in African regions affected by climate change (discussed in detail in Section 2). This research also fits within the extensive body of literature examining the determinants of conflict in Africa. Studies focusing on economic factors include works by McGuirk and Burke (2020); Dube and Vargas (2013); Blattman and Miguel (2010), while historical factors have been emphasized in studies by Besley and Reynal-Querol (2014); Michalopoulos and Papaioannou (2016); Moscona et al. (2020). Research on ethnic and social factors is represented by works such as Montalvo and Reynal-Querol (2005); Esteban et al. (2012); Rohner et al. (2013).

Furthermore, our research contributes to the recent economic literature on conflicts and land-use change by illustrating how political interventions can impact the occurrence of conflicts at the local level in areas where land is scarce. Previous studies have primarily focused on the relationship between deforestation and conflicts, suggesting that causality can be bidirectional (Burgess et al., 2015; Prem et al., 2020). Additionally, Cisneros et al. (2023) demonstrate how incentives to expand (oil palm) plantations can lead to violent conflicts.

Moreover, this paper is broadly related to the literature on the tragedy of the commons (Hardin, 1968). The tragedy of the commons is often exacerbated in areas where the usage rights over grazing land are weakly defined or unclear. In such circumstances, individuals may have little incentive to conserve the resource or invest in its long-term sustainability. This can result in a "race to the bottom," where each user seeks to maximize their individual benefits at the expense of others and the resource itself. Effective management of grazing land is crucial to prevent the tragedy of the commons. This may necessitate clear property rights or other rules for resource use, as well as robust monitoring and enforcement mechanisms. In several instances, community-based management systems, including those led by non-governmental organizations, have demonstrated success in reducing conflicts and promoting the sustainable use of grazing land (Ostrom, 1990).

Governmental solutions to address the tragedy of the commons mainly involve privatization, regulation, or taxation to internalize the externalities associated with the overuse of fertile land resources. For instance, Fetzer and Marden (2017) examine the impact of property rights on land conflicts and find that reducing the contestability of land can decrease conflict. The Anti-Open Grazing Laws (AOGLs), which impose restrictions on herders in 13 states of Nigeria, can be interpreted as a regulatory solution aimed at mitigating conflicts between farmers and herders over access to grazing land.

Finally, this paper relates to the literature on the relationship between institutions and economic development (Acemoglu, 2003; Acemoglu and Robinson, 2012; North, 1990; North et al., 2009). The seminal work by Acemoglu and Robinson (2012) highlights the crucial role of institutions in promoting economic growth and development, particularly emphasizing the significance of inclusive institutions that enable broad-based participation in economic and political decision-making processes. Additionally, foundational contributions in the field of new institutional economics argue that economic outcomes are shaped by a complex interplay between formal and informal institutions, including legal systems, property rights, and cultural norms (North, 1990). Both strands of research underscore the central role of institutions in shaping economic outcomes and have contributed to the understanding of the complex relationship between economic development and political economy. This literature suggests that political-economic institutions play a critical role in influencing the likelihood and intensity of conflicts over resources.

The remainder of this paper is structured as follows: Section 2 provides background information on herder-farmer conflicts in the broader context of Africa and specifically focuses on the case of Nigeria. In Section 3, we introduce the data used in our analysis. Section 4 presents our empirical strategy and reports the corresponding results. Finally, Section 6 concludes the paper.

2 Background

2.1 Herder-farmer conflicts across Africa

This paper primarily contributes to the evolving body of literature studying the causes of agro-pastoral disputes in Africa. Numerous studies have explored the link between climate change and violent conflicts. While some literature posits that climate change can to some extent explain the occurrence of violent conflicts, others cast doubt on such explanations. The proponents of the climate change hypothesis concede that even if no direct and linear relationship is observable in many instances, climate change and violent conflicts may be linked through indirect channels. Specifically, they argue that climate change can trigger factors like economic shocks or poverty, which can subsequently heighten the potential for conflicts. In a broader context, climate change can intensify competition for resources, affect livelihoods, and increase the propensity for disputes and insecurity — especially in areas already suffering from political, economic, and social tensions (IPCC, 2014; Burke et al., 2015; Madu and Nwankwo, 2020).

Specifically analyzing herder-farmer conflicts across Africa for the period 1989-2018, McGuirk and Nunn (2020) find that areas suitable for both agriculture and pastoralism are significantly more vulnerable to conflict than areas dedicated solely to either agriculture or pastoralism. Moreover, they demonstrate that precipitation shocks negatively affect conflicts in agro-pastoral zones at the country level, but not at the pixel level. These results suggest that agro-pastoral conflicts may be triggered by the migration of herding groups due to low precipitation rates in their native regions. In conclusion, their findings reveal one mechanism through which climate change can lead to an increase in conflicts in agro-pastoral areas.

Drawing from geolocalized conflict data for all African countries over the period 1997-2014, Eberle et al. (2020) demonstrate that an increase in temperature significantly raises the likelihood of conflict in areas where farmers and herders coexist. The study underscores that conflicts frequently occur in regions where farmland and rangeland intersect, given these areas are valuable for both agricultural and pastoral activities but are highly sensitive to climate shocks. This research also notes that temperature anomalies in the homelands of nomadic groups seem to expand land resource conflicts beyond their own regions. In summary, the analysis implies that competition over resources is a significant factor in violent farmer-herder disputes. Ultimately, the authors suggest that the implementation of policies that strengthen local communities, enhance participatory democracy, enforce property rights, and regulate land conflict resolution could reduce these violent actions.

Not all herder-farmer conflicts are primarily driven by scarce resources. For instance, the conflict in Darfur has been categorized as both an ethnic cleansing campaign carried out by the Sudanese government and its allies, as well as a local fight over increasingly limited resources between Arab pastoralists and African farmers (Olsson and Siba, 2013). The explanatory power of resource variables in their model is insignificant, and the spatial patterns of analyzed attacks indicate that ethnic cleansing is the primary motive rather than resource struggles. Additionally, Cao et al. (2021) provide evidence supporting the "culture of honor" hypothesis, indicating that traditional herding practices have fostered a value system conducive to revenge-taking and violence. Their comprehensive global analysis, based on various data sources, establishes systematic links between herding practices, the culture of honor in pre-industrial societies, and contemporary conflict dynamics, suggesting a persistent influence of herding-based economic subsistence on conflict behavior.

Another potential source of herder-farmer conflict may stem from agricultural policy, particularly efforts to convert pastoral land into agricultural land by governments or other institutions. Studies on agricultural development policies that prioritize such conversion have primarily employed qualitative empirical methods (Shazali and Ahmed, 1999; Ali, 2019). These policies often aim to enhance agricultural productivity and national food security but can disrupt traditional pastoral systems, leading to economic, social, and environmental consequences. Specifically, they can marginalize pastoral communities by reducing available pastoral land, disturbing migratory patterns, and intensifying conflicts over limited resources. Consequently, the literature highlights the importance of adopting inclusive and sustainable agricultural development policies that consider the needs and livelihoods of pastoral communities. Using a quantitative empirical approach with multiple identification strategies, McGuirk and Nunn (2023) examine the consequences of land use transformations on conflict in traditionally pastoral ethnic territories in Africa. Their analysis reveals that government-led agricultural development projects implemented in pastoral areas between 1995 and 2014 resulted in an increase in conflict. This escalation can be attributed to the disruption of customary land tenure arrangements and transhumance practices. Notably, agricultural projects in traditionally agricultural regions and non-agricultural projects in both regions did not exhibit the same effect. The findings underscore the significance of a "development mismatch", where development initiatives fail to align with the cultural context of local communities, which can amplify conflict, especially when political power is unevenly distributed.

Furthermore, according to Zambakari (2017), transhumant pastoralists, who traditionally operate within customary tenure regimes by accessing communal lands without formal titling, are facing an increasing vulnerability to land expropriation, often justified in the name of national interest. This vulnerability is exacerbated by the growing marketization of land, characterized by accelerated titling processes, which is leading to the widespread eviction of various producer groups, including agro-pastoral communities, nomads, and other transboundary groups engaged in seasonal movements. The forced displacement resulting from this phenomenon, often driven by the expansion of mechanized farming, not only disrupts their livelihoods significantly but also fuels violence as the dispossessed communities resort to confrontational strategies in their interactions with the state.

2.2 Herder-farmer conflicts in the context of Nigeria

Nigeria, currently ranking among the top ten oil-exporting countries, is well-known for its abundant natural resources. The country is often considered a prime example of the "resource curse" due to its oil wealth and related conflicts (Mähler, 2010). However, land is an even more crucial natural resource for the Nigerian economy at large. While oil and gas production make a significant contribution to Nigeria's GDP, accounting for approximately 10%, agriculture plays an even more substantial role, representing about a quarter of the total GDP and employing over 35% of the labor force. Crop production constitutes the largest portion of the agricultural output, making up around 87%. Livestock, fishing, and forestry contribute shares of approximately 8.1%, 3.2%, and 1.1%, respectively (2021).[4]

Smallholder farmers in the southern part of the country are primarily engaged in the production of root crops and vegetables, while pastoralists in the northern region focus on raising livestock and cultivating grains. The former group comprises various ethnic groups, often with a Christian religious identity, whereas the latter predominantly consists of the Fulani community, who are mostly Muslims. It is estimated that over 90% of pastoralists in Nigeria are Fulani (Zhao et al., 2020), an ethnic group spread across Central and West Africa (Arnott, 1960). The Fulani pastoralists own approximately 90% of the country's livestock, which contributes around 30% to the gross agricultural output of national GDP. The livestock trade involves significant transboundary activities and movements among herders, with most of the livestock being brought in and out of the country (FAO, 2017). As a common practice, pastoralists migrate with their cattle from the northern and western regions, traversing the arid Sahel zone and moving along the Northern Belt of Nigeria, which includes parts of the Sahara Desert. For

[4] Source: www.pwc.com

a detailed description of the migration patterns of herders in West Africa, see Moritz (2010); Brottem (2016); McGuirk and Nunn (2020).

Historically, dating back to the 19th century, pastoralists began altering their migratory routes, moving further south (Blench, 1994). The common narrative is that this shift in migratory patterns was triggered by emerging drought conditions in the north. These conditions encouraged a move towards the relative safety of the central and southern regions, which also had a lower level of trypanosomiasis infestation. In addition, it is reported that the pastoralists sought to evade the cattle tax, colloquially known as *Jangali*, which was levied by the colonial rulers in the northern region (Adebayo, 1995). This southward migration of the cattle herders presumably led to competition and violent conflicts between pastoralists and farmers.

The reasons for the latest occurrences of herder-farmer conflicts are described as multi-faceted and complex. As pointed out before, agro-pastoral conflicts are compounded by religion and ethnicity. Nevertheless, inadequacy of land resources is often determined as the main reason, especially in the last two decades. Due to a population increase in North Central Nigeria, the demand for land increased as well. Often this takes place in regions that have traditionally been used as cattle grazing areas. Concurrently, Boko Haram incidents and climate change have decreased land resources suitable for grazing in Northeast Nigeria, pushing herding groups to more Southern areas. Farmer-herder conflicts can often be characterized by attacks by one group followed by revenge actions from the other community (World Bank, 2018).

Consistent with this explanation, Madu and Nwankwo (2020) empirically demonstrate that the widespread conflicts across Nigeria, with hotspots in the Middle Belt region and particularly in Benue State, are closely tied to climate change vulnerability in the North. One potential explanation for this could be that herders' migration patterns are changing, causing them to shift increasingly southwards. The authors also highlight that these hotspot states are the country's primary food-producing regions. Consequently, herder-farmer conflicts have significant potential to undermine national security and food security, particularly in rural communities where these conflicts are primarily located, with costs that reverberate nationwide.

Indeed, Nnaji et al. (2022) discover that herder-farmer conflicts in Nigeria significantly exacerbate food insecurity, with the intensity of the conflicts having a greater impact. These findings emphasize the need for policy interventions to mitigate farmer-herder conflicts and promote sustainable food security.

2.3 Political intervention at the state level

2.3.1 Parties and affiliations to herders and farmers

Nigeria operates as a federal republic with a national government as well as 36 state governments. The form of governance employed is a representative democracy. While Nigeria has a multi-party political system, two major parties dominate the political game: the currently ruling All Progressive Congress (APC), which controls all the northern states except for Adamawa, Sokoto, Bauchi, and Zamfara, and the opposition People's Democratic Party (PDP), which governs most of the southern states. Due to this dichotomy, herder-farmer conflicts are sometimes interpreted as political dispute, where political elites from the two dominant parties leverage the conflicts to gain political advantage (Vanger and Nwosu, 2020; Madu and Nwankwo, 2020; Allern et al., 2021).

In Nigeria's federal structure, political power is fairly centralized and divided between the federal government and the 36 state governments, enabling substantial authority for state governments in several areas, including land use and policy. Under the Land Use Act of 1978, part of Nigeria's constitution, all land within a state is vested in the governor of that state, who holds the land in trust and administers it for all citizens (Constitution of the Federal Republic of Nigeria, 1999). This autonomy implies that state governments and governors have discretion in fulfilling their constitutional responsibilities. Often, state autonomy is interpreted as the unfettered freedom of the state government to make decisions, as long as these decisions are within the bounds of the constitution. This autonomy also affords state governors the ability to implement certain laws in collaboration with other states (Osaghae, 2003). As Banko (2020) indicates, state policies are frequently influenced by political party affiliations. Therefore, it is not uncommon to observe state governments from the same political parties adopting similar public policies and laws.

Apart from political party affiliation, the state governors also align along geographical regions. The constitution recognizes the formation of the "Southern Governors' Forum" and "Northern Governors' Forum" (Anyadike, 2015). The governors' forum comprises governors in the same region and from different political parties and is therefore, non-partisan. The platform was created to enhance collaboration among the executive governors of Nigeria from within the Northern region or Southern region (Anyadike, 2015). The Open Grazing Prohibition and Establishment of Ranches Law was, therefore, adopted under the platform of the "Southern Governors' Forum" though ratified at different times by different Southern governors.[5]

Although governors hold the position of chief security officers of their states, their ability to coordinate responses to violence between herders and farmers is somewhat limited. This limitation stems from the fact that the control of the police and security services predominantly rests within the jurisdiction of the federal government.

Nevertheless, given the persistent occurrence of herder-farmer conflicts in Nigeria, the role of state governors in formulating and implementing land use policies becomes crucial. In addition to enacting grazing laws, state governors have the potential to mitigate land conflicts by establishing designated grazing reserves for herders, thereby preventing encroachment onto farmland. Moreover, governors can implement conflict resolution mechanisms at both the state and local levels, including the utilization of traditional and community-based dispute resolution methods.

2.3.2 Anti-Open Grazing Laws and their enforcement

In response to the violent conflict between herders and crop farmers, the government of Ekiti State enacted "A Law to Regulate and Control Cattle Grazing in Ekiti State and Other Matters Connected Therewith" in 2016 (Ekiti State Nigeria, 2017). This legislation is commonly referred to as the Anti-Open Grazing Law (AOGL), which aims to reduce violent conflicts between farmers and cattle herdsmen

[5] See, for example: https://www.thisdaylive.com/index.php/2021/05/17/eight-southern-states-set-to-enact-anti-open-grazing-law

in the region. For instance, Section 2, which describes prohibited actions, stipulates that "no person shall cause or permit any cattle or other ruminants belonging to him or under his control to graze on any land which the Governor has not designated as a ranch." Additionally, all grazing must occur between 7:00 am and 6:00 pm. The penalty provision, Section 6, states that any person who contravenes the law or the regulations set by the Commissioner "shall be imprisoned for a period not less than six months without the option of a fine."

The law stipulates six primary objectives to be achieved (Ekiti State Nigeria, 2017): (1) preventing the destruction of crop farms, community ponds, settlements, and property by open rearing and grazing of livestock; (2) preventing clashes between nomadic livestock herders and crop farmers; (3) protecting the environment from degradation and pollution caused by open rearing and overgrazing of livestock; (4) optimizing the use of land resources in light of overstretched land and increasing population; (5) preventing, controlling, and managing the spread of diseases while facilitating the implementation of policies that enhance the production of high-quality and healthy livestock for local and international markets; and (6) creating a conducive environment for large-scale crop production.

During our investigation period, besides Ekiti in 2016, the states of Edo, Benue, and Taraba enacted Anti-Open Grazing Laws (AOGLs) in 2017, which closely resemble the law passed in Ekiti. As of 2022, 13 of the 36 Nigerian states have passed similar laws.

However, the AOGLs have been met with a mixed response of support and disapproval. Supporters of the law, who are primarily individuals and governments from states where farmer-herder clashes frequently occur, believe the law will help put an end to these ongoing conflicts. Many state governors view the law as a remedy for conflicts within their jurisdictions. However, critics argue that the law is discriminatory and could lead to increased costs for the livestock business in the country. Kwaja and Ademola-Adelehin (2017) contend that the law has prompted herders to relocate to border towns of the states where the laws have been enacted.

Enforcement of the law has primarily been carried out by local vigilantes formed by the state. In general, the states of Nigeria and their governors do not have legal control over the Nigerian security architecture, such as the police and the military. Consequently, the governors of the states had to devise alternative security forces, separate from the recognized state security apparatus, to enforce the laws. For instance, the Amotekun, a security structure formed by the state governors, was tasked with enforcing the law on behalf of the states. These local vigilantes were provided with arms and ammunition funded by state revenues and licensed to bear and use arms against aggressive defaulters. A study by Danilo Gomes de Arruda (2021) reported that since the formation of the Amotekun forces, over 87 herders have either been captured or killed from 2019 to 2021.

However, since the Amotekun is not recognized by the central government, as well as, the constitution of the federal republic of Nigeria, many social commentators have argued that the operation of the forces is illegal and tantamount to the escalation of violence. In response to the violence meted out by the Amotekun to the herders, an armed militia of herders under the guise of the "Miyetti Allah Cattle

Breeders Association of Nigeria" (MACBAN) emerged.[6] The militia claims that its goal is to provide security for its members against the so-called onslaught from the state (Ikani et al., 2011).

3 Data

3.1 Grid

To analyze the spatial effects of the implementation of Anti-Open Grazing Laws, we overlay a grid of 0.1×0.1 degree pixels (0.1 degree corresponds to approximately 11.1 km at the equator) over Nigeria. Next, we intersect this grid with a map of the borders of all 36 Nigerian states to determine the state in which each pixel is located. Border pixels are not removed; instead, we use trimmed pixels along the borders. The final sample consists of 186,199 cells covering the period from 2010 to 2022. We merge all the remaining data discussed below on this grid (refer to Figure 1).

3.2 Conflict data

The main dependent variable of our empirical model is conflicts at the pixel level, which is generated using the Armed Conflict Location & Event Data Project (ACLED) (Raleigh et al., 2010). ACLED is a collection of conflict event data from various sources, typically national and regional media or NGOs. It also includes police reports and social media data. The conflict data is available for the years from 1997 onwards and is geocoded with longitude and latitude information for each reported observation. This enables us to assign each conflict to a pixel-year pair.

In Nigeria, approximately 28,000 conflicts were reported across all categories from 2000 to 2022. A major advantage of ACLED is the high level of detail it provides for each observed conflict, including information on the involved actors and types of conflicts.[7] Using these variables, we have identified 6,362 *herder-farmer* clashes. We then generate conflict variables, including a binary variable taking on the value 1 when at least one conflict falls within a pixel-year entity.

Figure 1 illustrates these identified conflicts on our grid of cells, while Figure 2 depicts the evolution of total herder-farmer conflicts over time, differentiated by states that enacted treatments and control states. We observe a similar pattern for both groups, consisting of 13 treated states and 26 non-treated states. Specifically, we detect a surge in conflicts from 2012 onwards, when the total reported herder-farmer-related conflicts first exceeded 100. Since then, an upward trend is evident, which coincides with a steeper increase in conflicts following the implementation of Anti-Open Grazing Laws (AOGLs) from 2016 onward. The year 2021 marks the peak of herder-farmer-related conflicts, with over 900 reports.

We further subdivide herder-farmer conflicts into two categories: *herder or farmer-related* conflicts and *herder vs. farmer* conflicts. The first category includes engagements with militias or security forces,

[6] See, for example: https://dailypost.ng/2017/01/30/miyyeti-allah-cattle-breeders-standing-army-can-destroy-national-peace-group/

[7] Another valuable resource for identifying herder-farmer conflicts is the Uppsala Conflict Data Program (UCDP) database. However, when applying our methodology to this source, we were only able to identify 222 herder-farmer conflicts from 2000 to 2022. Due to this limited variation, we decided to rely on the ACLED database, as it provides a greater quantity and quality of information on herder-farmer conflicts within our specific context.

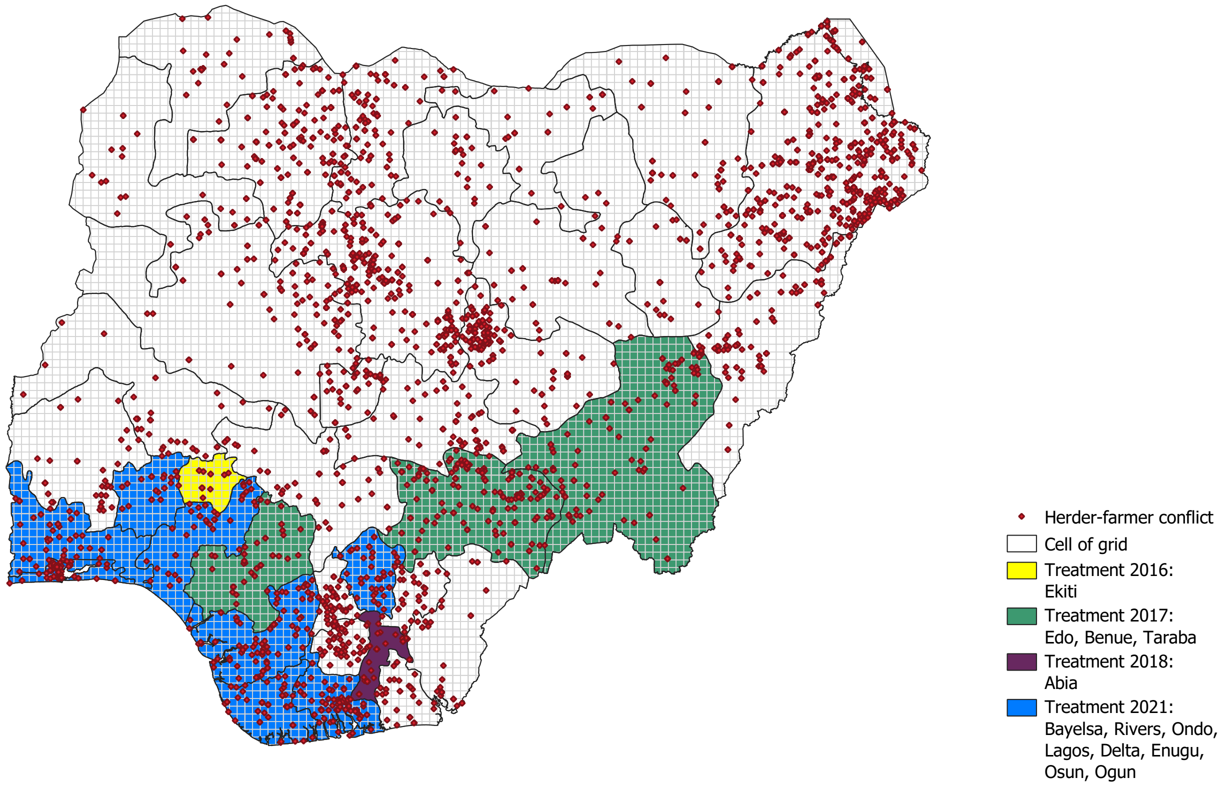


Figure 1: HERDER-FARMER CONFLICTS AND GRID INDICATING TREATED PIXELS. This figure shows a political map of Nigeria at the tier 1 level with an overlay of a grid consisting of mainly 11.1 x 11.1 km cells. The red dots indicate the locations of all 6,362 herder-farmer conflicts that we identified in the ACLED dataset. The colored areas, as reported in the legend, represent the treated states and the respective years of law implementation.

such as revenge attacks by either herder or farmer-related groups encountered by security forces. It further excludes conflicts where only herders and farmers were the opposing parties, which is the criterion for a conflict event being assigned to our second category: *herders vs. farmers*.[8]

3.3 Luminosity data

We utilize nighttime luminosity as a proxy for local-level urbanization (Alesina et al., 2016; Hodler and Raschky, 2014; Michalopoulos and Papaioannou, 2016; Bruederle and Hodler, 2018; Henderson and Turner, 2020). These data are derived from satellite images of the Earth at night captured by the US Air Force (USAF) Defense Meteorological Satellite Program Operational Linesman System (DMSP-OLS). The original images are processed by the National Oceanic and Atmospheric Administration (NOAA) and released as raster datasets. We utilize the annual composites obtained from satellites F10, F12, F14, F15, F16, and F18, where ephemeral lights, such as fires and flares, are removed. The processing also excludes images affected by clouds, moonlight, sunlight, and other glare at the pixel level. The available images have a resolution of 30 arc-seconds (approximately 0.86 square kilometers at the equator) for all

[8] A detailed description of our herder-farmer conflict identification procedure is provided in the Appendix (A.1).

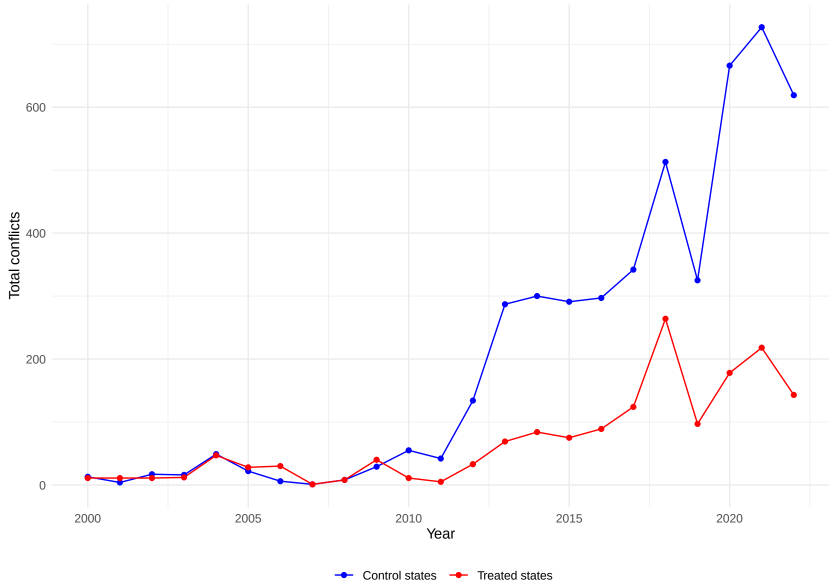


Figure 2: DEVELOPMENT OF HERDER-FARMER CONFLICTS OVER TIME (2000-2022). This figure displays the total number of identified *herder-farmer* conflicts for the treated and control states.

years after 1992. Each pixel in the dataset represents a 6-bit digital value ranging from 0 to 63, indicating the average amount of light emitted by the corresponding 30 arc-second area. Higher values indicate a greater amount of emitted light (Henderson et al., 2012).

The initial release of the stable lights data time-series ended in 2013, but it has recently been extended with data collected from satellites F15 and F16 for the period 2014-2021. Starting from the beginning of 2014, the F18 satellite ceased capturing usable nighttime data. Consequently, the focus shifted towards processing global nighttime images from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) data. However, it was later discovered that satellite F15 had been collecting pre-dawn nighttime light data since 2012, and satellite F16 may have also collected usable nighttime data during the pre-dawn hours. Based on this new information, the Earth Observation Group (EOG) has extended the annual nighttime lights time series by enhancing the established algorithms used in previous years to process DMSP-OLS data from 2013 onwards (Ghosh et al., 2021).

To obtain a cell-level measure of economic development, we overlay the grid of cells onto the raster datasets and calculate the mean value of the digital values for each cell with a size of 30 arc-seconds that falls within the boundaries of each cell (see Figure A.3).

3.4 Vegetation data

Spatial and temporal patterns of herder-farmer conflicts are closely tied to the availability of fertile land resources. To systematically account for vegetation dynamics across Nigeria, we utilize the Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Index (VI) datasets, specifically the Normalized Difference Vegetation Index (NDVI), for the time period from 2000 to 2022 (DAAC, 2018).[9] These raster datasets derived from satellite data provide an effective and reliable approach for mon-

[9] MOD13A2: MODIS/Terra Vegetation Indices 16-Day L3 Global 1km product

itoring vegetation phenology and photosynthetic activity over both space and time. To obtain yearly averages, we stacked the 16-day raster files into composite yearly raster files. Subsequently, following the previously outlined procedure, we computed cell-level NDVI values over the entire time series.

The NDVI quantifies vegetation vigor by measuring the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). The standardized values range from -1 to 1. Negative values typically represent non-vegetative surfaces such as water, snow, or clouds. Values close to zero correspond to barren areas composed of rock, sand, or urban landscapes. Values between 0.1 and 0.4 represent areas with low vegetation, such as grasslands or prairies, while values above 0.4 indicate densely vegetated areas like temperate and tropical rainforests.

3.5 Precipitation data

Precipitation is a critical variable in the study of herder-farmer conflicts and land resource conflicts in general because it directly affects the availability of water for agricultural and livestock activities. Insufficient rainfall or limited access to water can lead to competition between farmers and herders for resources, potentially resulting in conflicts over land, grazing rights, and water resources. In areas with significant variations in rainfall, such as Nigeria, changes in precipitation patterns can have substantial impacts on local communities and their livelihoods.

To calculate local precipitation rates, we obtain precipitation data from the TerraClimate project (Abatzoglou et al., 2019). The TerraClimate dataset is a global gridded dataset of monthly climate and climatic water balance variables spanning from 1958 to 2020. It provides high-resolution data (4 km x 4 km) on several variables, including precipitation, temperature, vapor pressure, solar radiation, and wind speed. The precipitation variable in TerraClimate is based on observations from the Global Historical Climatology Network-Daily (GHCN-D) and the Climate Anomaly Monitoring System (CAMS), which are merged with precipitation estimates from the Global Precipitation Climatology Centre (GPCC) Full Data Reanalysis Version 7 and the Climate Prediction Center (CPC) Morphing technique (CMORPH) Version 1.0. recipitation in the TerraClimate dataset is measured in millimeters (mm) of water equivalent per month. From this variable, we calculate yearly averages at the cell level (see Figure A.5).

3.6 Population data

We retrieve population data from the WorldPop Project.[10] For the years 2000-2020, the dataset captures annual gridded population as raster files. The population values per pixel in the WorldPop dataset are based on recent official census population data and various other input data sources, including the location and extent of settlements, roads, land cover, building maps, satellite nightlights, vegetation, topography, health facility locations, and refugee camps. Methodological details regarding the random forest regression tree based mapping approach used to generate gridded pixel data at spatial resolutions of 1 km and 100 m are provided by Stevens et al. (2015).[11]

[10] https://www.worldpop.org

[11] https://www.worldpop.org/methods/

To estimate population sums at the grid level, we use the raster datasets with a 1 km resolution. For a cell-level measure of population development, we overlay the grid of cells onto the yearly raster datasets. We then calculate the sum of the digital values for each cell with a size of 30 arc-seconds that falls within the boundaries of each cell (see Figure A.4).

3.7 State governors and party affiliation

We manually collect data on state governors, including their party affiliations, for the period of investigation and merge this data with our sample at the state level. This allows us to control for the party affiliation of state governors. The vast majority of governors in our sample have an APC or PDP party affiliation.

3.8 Further geo-coded data

We source geographical data of specific features across Nigeria using a combination of OpenStreetMap (OSM) and the Overpass API. These features include water bodies, police stations, churches, and mosques. We obtain their locations by querying the Overpass API for the respective tags associated with these features on OSM. The Overpass API allows us to extract geo-spatial data from the OSM database and provides the latitude and longitude coordinates for each queried feature, accurately pinpointing their exact locations.

To gather information on the locations of security forces related to herder-farmer conflicts, we relied on Google Maps. We used the search and pinpoint functions to map these locations. We incorporated these data points into our dataset for subsequent analysis.[12]

To calculate the distances from each centroid of our grid cells to the closest feature in each category (water body, police station, church, mosque, and private security force) as of 2022, we used the haversine formula. The haversine formula calculates the shortest distance between two points on the surface of a sphere.

3.9 Summary and comparison statistics

Summary statistics of our total sample for the period of investigation (2010-2022) are presented in Table A.1, while Table A.2 provides summary statistics divided by law-enacting states (treated states) and the remaining states (control states). We observe notable differences between the law-enacting states and the remaining states. This descriptive evidence is expected since the treated states are located in southern Nigeria and the Middle Belt, which are regions that are more fertile in terms of land resources compared to the northern and Sahel parts of the country, where the Sahara begins. Consequently, the means of NDVI and precipitation are significantly larger in the treated states.

Additionally, the means of luminosity and population indicate higher levels of urbanization in these areas. The southern part of Nigeria is characterized by greater urbanization compared to the northern

[12] We identified the location of the following security forces related to enforcement of AOGLs: Amotekun Corps, Ondo State Security Network Agency, Civilian J.T.F. Nariya Kaduna, Kakuri Civilian J.T.F, Ekiti State Security Service, Vigilante Group of Nigeria.

part, due to the presence of significant cities within the treated states, such as Lagos, Port Harcourt, and Benin City. Lagos, the largest city in Nigeria, serves as a major economic and financial hub with a population exceeding 20 million. Port Harcourt, located in Rivers State, is a crucial industrial and oil-producing center, while Benin City, the capital of Edo State, boasts a rich cultural heritage and historical artifacts. These cities contribute to the higher population numbers and increased luminosity observed in law enacting states compared to the control states.

Table A.3 displays summary statistics for cells that fall within a 50 km radial buffer at the border of treated states.[13] We observe that cells within both treated and control states exhibit high similarity regarding variables related to herder-farmer conflicts. Therefore, we conclude that our empirical specifications, utilizing observations in proximity to the border of treated states, are similar in all relevant aspects that may affect herder-farmer conflicts, except for the treatment itself. This enables us to interpret the subsequent evidence, leveraging the discontinuity of grazing laws at the border, in a causal manner.

4 Empirical strategy

Our goal is to study how the implementation of Anti-Open Grazing Laws in several states of Nigeria affects the occurrence of herder-farmer conflicts at the cell-level in both the 13 law-enacting states[14] and neighboring states, as well as the rest of the country. We begin by analyzing potential effects around the borders of states that enacted AOGLs. Therefore, we restrict our sample to all cells that fall within certain radial buffers (25 km, 50 km, 100 km, 200 km) around the borders of treated states. We then identify all cells whose centroids fall within the border regions of the treated states and refer to these cells as "treated cells". Hence, our control group consists of cells that fall within the border regions (as defined above) of states that did not implement similar laws.

Specifically, we use a difference-in-differences model at the border (differences-in-discontinuities) to estimate the potential effects on one side of the border relative to the other side by comparing outcomes before and after the policy change in both treated and control cells. Figure 3 visualizes conflicts in the treatment group and conflicts in the control group for different buffer sizes.

We exploit the abrupt change in legal conditions at the border, which serves as a type of natural experiment, to test whether the law has affected a specific side. The fundamental concept behind a difference-in-differences model at the border is to leverage the sharp discontinuity created by the border to establish treatment and control groups. This approach assumes that the two sides of the border are comparable in all relevant aspects except for the policy change (i.e., the AOGL implementation) (Butts, 2021; Wuepper and Finger, 2023).

Therefore, we narrow our sample to cells proximate to the border as shown in Figure 3. This process plausibly generates treatment and control groups that are identical in all relevant factors that influence the likelihood of conflicts involving herders or farmers, with the exception of the law implementation. For observable variables, we indeed demonstrate a high degree of similarity between the two regions up

[13] Tables A.4 and A.5 report these statistics for 100 km and 200 km buffers, respectively.

[14] Ekiti, Edo, Benue, Taraba, Abia, Bayelsa, Rivers, Ondo, Lagos, Delta, Enugu, Osun, Ogun

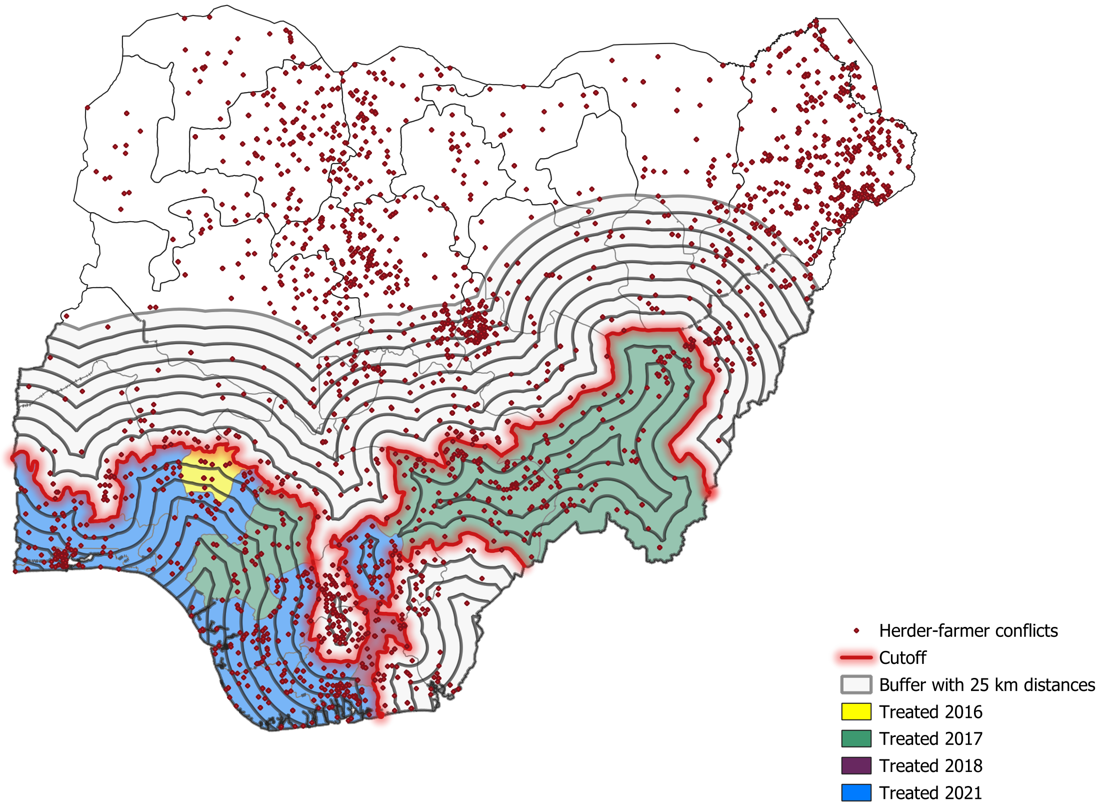


Figure 3: GEOGRAPHICAL DESIGN OF THE BASELINE SPECIFICATION. This figure shows a political map of Nigeria at the tier 1 level. The red dots indicate the locations of all 6,362 herder-farmer conflicts that we identified in the ACLED data set. The colored areas as reported in the legend represent the treated states and the respective years of law implementation. The 25 km buffers indicate the distances for the treatment and control assignment of our baseline specification. The underlying grid of cells is not displayed for simplicity reasons.

to 50 km from the border (see section 3.9). It is important to note that all cells in this sub-sample are located within the Middle Belt or southern Nigeria, inclusive of the Niger Delta region. These regions, characterized by a tropical climate, have traditionally been utilized for both agricultural and pastoral activities due to the significantly higher average annual rainfall compared to the arid northern states of Nigeria located near the Sahel region.

The model can be formalized as follows:

$$Y_{it} = \rho D_{it} + \beta X_{it} + \gamma_i + \lambda_t + \varepsilon_{it}, \tag{1}$$

where Y_{it} is the (binary) conflict variable in cell i in year t, D_{it} is the main variable of interest - a dummy indicating the presence of an Anti-Open Grazing Law -, X_{it} is a vector of covariates consisting of the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 representing PDP and 0 representing APC or another party. γ_i controlling for systematic (but time-invariant) differences between cells, λ_t capturing year-specific country-wide effects.

As the data on conflict occurrences in the ACLED dataset partially depends on media coverage, some regions may receive less (or more) media attention than others. This discrepancy could potentially lead to underreporting or overreporting. Our empirical model accounts for this challenge by including the previously mentioned cell-fixed effects (γ_i).

The AOGLs have been implemented by various states at different times. As such, the empirical setting introduces challenges related to heterogeneities in the treatment effect. To address these challenges, and in response to recent econometric concerns associated with staggered difference-in-differences research designs, we adopt the methodology proposed by Sun and Abraham (2021), specifically designed to tackle these issues.

The method involves estimating the treatment effect for each cohort, followed by computing the average of these estimates using cohort-specific weights. The analysis is then repeated, this time incorporating the inclusion of covariates. It is important to note that in their specification, the cohort-specific average change in outcome relative to never having been treated is estimated by default. In our specification using the Sun and Abraham (2021) methodology, the control cells consist solely of the sides of the border that were never officially affected by AOGLs. However, we also tested cells that were not yet treated and those never treated, instead of only those never treated, as control groups. The results, which we will present later, do not differ under these conditions.

The critical identifying assumption in difference-in-differences designs is that, in the absence of treatment, the treated and control cells would have exhibited parallel trends. This assumption is particularly pivotal in the context of our analysis, given that the enactment of laws is not a random occurrence in states. To test the robustness of our results against potential breaches of the parallel trends assumption, we gauge event-studies. This allows us to discern whether relatively frequent conflict events systematically precede the enactment of laws.

5 Results

5.1 Main results

We use cross-sectional data from 2015, a year prior to the first treatment, and 2022, a year following the implementation of AOGLs by 13 states, as depicted in Figure 4. This figure illustrates our estimation approach and provides preliminary evidence. Conflicts are sorted into cells or bins based on their distance from the borders of treated states. We estimate the average occurrence of conflicts from each bin and fit models of first and second polynomial order to the data. No break at the border is evident in 2015, whereas a clear discontinuity becomes observable by 2022. The difference-in-discontinuity estimate (2022-2015, see column 6 in Table A.6 in the Appendix) suggests a 3.7% decrease in herder-farmer conflicts in the cells of treated states compared to their neighboring cells. Moreover, the graph indicates an increase in conflicts on both sides of the border between 2015 and 2022.

Supporting this finding, Figure A.7 illustrates an upward trend in the average conflict occurrence in border regions surrounding the states that implemented the treatment. Notably, substantial increases are observed following the treatment implementation. This descriptive data suggests that border re-

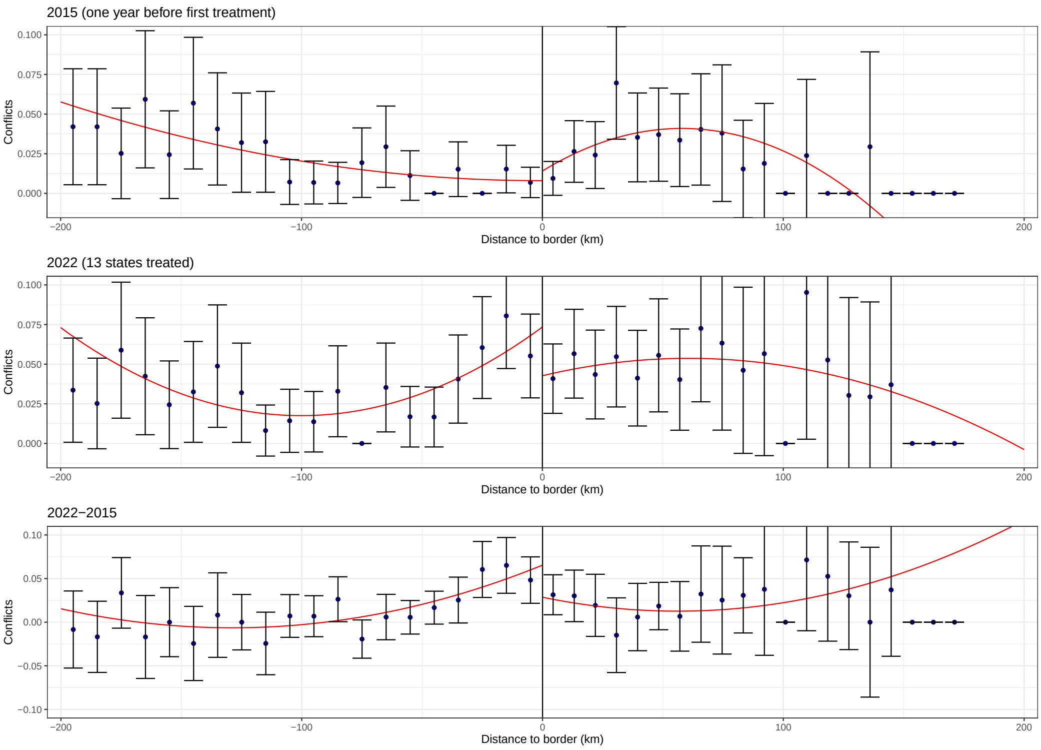


Figure 4: REPRESENTATION OF THE DIFFERENCE-IN-DISCONTINUITIES ESTIMATOR WITH TWO CROSS-SECTIONS (2015 AND 2022). This figure displays cross-sectional estimates and 95% confidence intervals of the distance-to-border specification for the years 2015 and 2022, along with their differences (2022-2015). Each dot represents the average conflict occurrence within bins of 10 km. The corresponding estimation results are provided in Table A.6 (see Appendix).

gions around the treated states experienced a surge in conflicts during the period of law enforcement, particularly when contrasted with cells in other parts of the country.

We now employ the geographic difference-in-discontinuities design, using the annual panel data from 2010 to 2022. We first investigate conflict spread using the binary conflict variable, then analyze conflict numbers. The binary variable is likely to capture conflict spread as it clearly indicates the number of cells with conflicts present before and after the treatment. This information is invaluable in understanding the geographical extent and spatial distribution of conflict over time. While a binary conflict variable on a grid provides a straightforward measure of conflict spread, a variable capturing total numbers per cell can be interpreted as conflict frequency.[15] Both measures offer distinct perspectives and contribute to a comprehensive understanding of conflict dynamics.

The results, using the binary conflict variable, are presented in Table 1. The largest coefficient is estimated near the borders (columns 1 and 2), and it diminishes as the distance from the borders of treated states increases. This finding suggests that the laws have reduced the reported spread of conflicts in treated states relative to neighboring states, up to a distance of 50 km from the state borders. To clarify the size of the estimate, Edo state, for example, comprises approximately 159 grid cells. A reduction

[15]Figure A.2 in the Appendix shows the distribution of conflicts at the cell-year level. Over 60% of cells with reported conflicts count only one conflict.

Table 1: SPREAD OF *herder-farmer* CONFLICTS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0168***	-0.0123***	-0.0122***	-0.0099***	-0.0081***	-0.0045***	-0.0025**	0.0009
	(0.0028)	(0.0031)	(0.0020)	(0.0022)	(0.0013)	(0.0015)	(0.0011)	(0.0013)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflict spread in regions of states that implemented these laws compared to regions in neighboring states. The binary dependent variable represents the occurrence of herder-farmer conflicts at the cell level. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the cell and year levels, to account for potential correlations within individual cells and over time.

of 1.7% would imply that more than 2 cells, each equivalent to 123.21 km^2, are no longer affected by herder-farmer conflicts due to the treatment.

We validate the parallel trends assumption by presenting event studies of this model, as shown in Figure 5. Specifically, we utilize six dynamic estimation approaches to test the robustness against heterogeneities in the treatment effect.[16] The event studies reveal no systematic differences in pre-trends. Overall, the plots suggest a lagged negative impact, as significant decreases can be observed in years 5 and 6 following the treatment implementation.

Our analysis of the full variation of the conflict variable, based on the frequency of conflicts per cell, is presented in Table A.7 (Appendix). Notably, we find no impacts, suggesting that the enactment of these laws did not result in a decrease in conflict frequency in treated states compared to their neighboring states.

However, we propose a hypothesis: the observed reduction in conflict spread near the borders of treated states may be attributed to the deployment of additional security forces in rural areas, as described in Section 2.3.2. Even though the overall conflict frequency remains unaltered, these augmented security measures might have restricted the geographical scope of conflicts near state boundaries. We suggest that the combination of these additional security forces and the alleged discriminatory aspects of AOGLs could have motivated herder communities or associated groups to relocate to nearby states. Moreover, the descriptive evidence depicted in Figure 4 and Figure A.7 implies that this significant decrease in conflict dispersion at the borders of treated states likely triggered an increase in both conflict dispersion and frequency in neighboring states.

We proceed to examine the total sample, as depicted in Figure 1. In this analysis, we categorize all cells within states that implemented AOGLs as the treatment group, and the remaining cells are

[16] TWFE, Callaway and Sant'Anna (2021); Roth and Sant'Anna (2023); Borusyak et al. (2022); Gardner (2022); Sun and Abraham (2021)

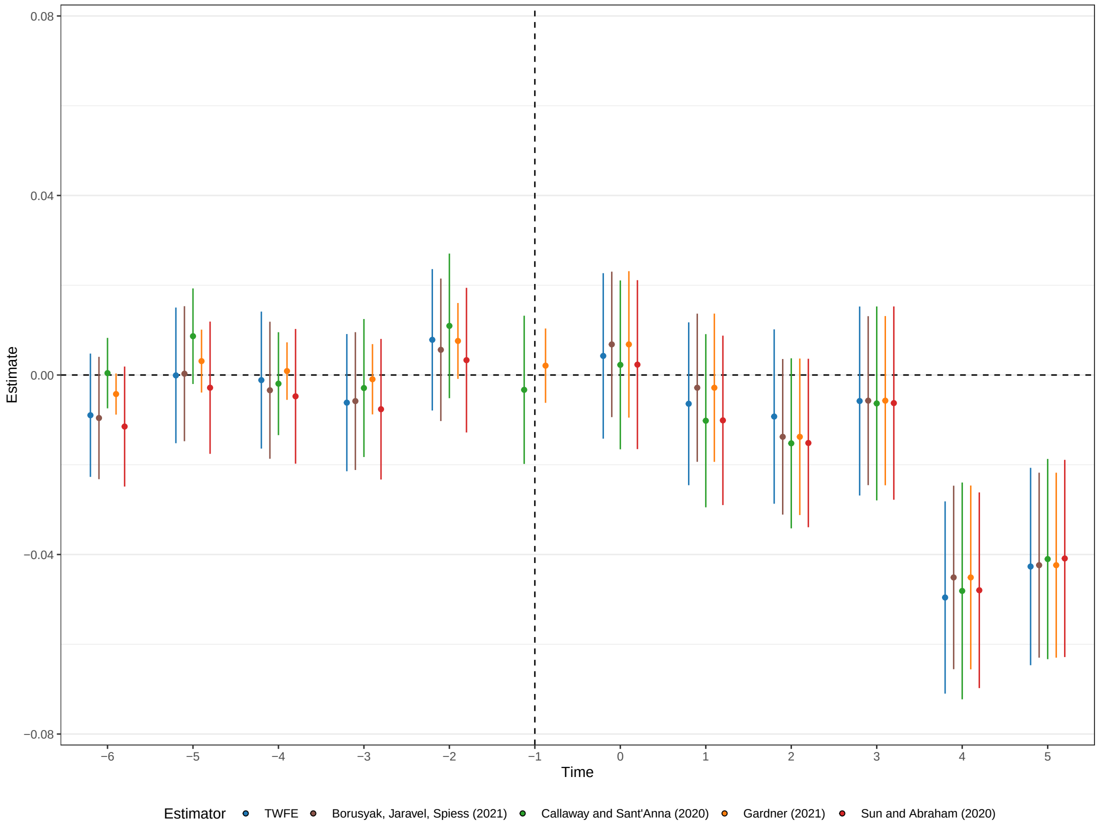


Figure 5: EVENT-STUDY: SPREAD OF HERDER-FARMER CONFLICTS This figure presents the event-study plots for the sample within a 25 km bandwidth. The results are generated using six different estimators to examine the impact of the enactment of Anti-Open Grazing Laws in year $t = 0$ on herder-farmer conflicts. The estimators utilized include the dynamic version of the TWFE model (blue), Gardner (2022) (red), Sun and Abraham (2021) (red), Callaway and Sant'Anna (2021) (green), Roth and Sant'Anna (2021) (purple), and Borusyak, Jaravel, and Spiess (2021) (brown). These estimates were computed using the *did2s* R package. Comparison groups were defined by the default settings: not-yet treated and never-treated entities (cells). The x-axis represents time, measured in years, with the vertical reference line indicating the reference period. The y-axis shows the estimates for the binary conflict variable. The bars on the plot represent 95 percent confidence intervals, with standard errors clustered at the cell level.

categorized as the control group. We continue to use the Sun and Abraham (2021) estimator with conflict frequency as the outcome variable, and present the results in Table A.8 (Appendix). The analysis across all regions in the country reveals no statistically significant differences. This result aligns with the findings from our border specification. Consequently, we infer that up until 2022, the laws did not reduce the frequency of herder-farmer conflicts in treated states compared to control states.

5.2 Extensions and robustness tests

5.2.1 Herders vs. farmers

We categorize our sample into two groups: *herder or farmer related* conflicts (which include security forces as a party) and explicit conflicts between herders and farmers (*herders vs. farmers*), as elaborated in Section 3.2. The geographical design using these distinct conflict categories is shown in Figure A.8 in the Appendix. Applying our primary model, we present the results for these groups separately in Tables 2 and 3.

Table 2: FREQUENCY OF *herder or farmer related* CONFLICTS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0146**	-0.0074	-0.0130**	-0.0077*	-0.0027	0.0015	0.0022	0.0056*
	(0.0055)	(0.0059)	(0.0043)	(0.0043)	(0.0032)	(0.0033)	(0.0028)	(0.0031)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflict frequency in regions of states that implemented these laws compared to regions in neighboring states. The dependent variable represents the number of conflicts of the category *herder or farmer related* at the cell level. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the cell and year levels, to account for potential correlations within individual cells and over time.

Table 3: FREQUENCY OF *herder vs. farmer* CONFLICTS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	0.0037***	0.0046***	0.0025***	0.0032***	0.0017***	0.0023***	0.0018***	0.0024***
	(0.0008)	(0.0011)	(0.0006)	(0.0008)	(0.0004)	(0.0006)	(0.0003)	(0.0005)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflict frequency in regions of states that implemented these laws compared to regions in neighboring states. The dependent variable represents the number of conflicts of the category *herder vs. farmer* at the cell level. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the cell and year levels, to account for potential correlations within individual cells and over time.

Interestingly, the results suggest a significant decrease in the *herder or farmer related* conflict category within a 50 km radius of the border (columns 1 to 3), while a positive sign appears as the distance from the border increases (columns 5 to 8). This pattern implies that conflicts involving herders or farmers, with security forces or militias as parties, decreased only in the border regions of treated states relative to the border regions of neighboring states. However, it is important to note that this might result in an increase in conflicts in the border regions of the neighboring states, as previously discussed.

Conflicts in which herders and farmers are explicitly opposing parties follow a different pattern, with all distance coefficient signs being positive (Table 3). This could potentially be explained by inadequate enforcement of AOGLs in terms of reducing conflicts between herders and farmers. An alternative hypothesis might be that herder or farmer groups could be instigated to engage in acts of vigilante justice or revenge, driven either by the presence of additional security forces targeting herders, or the law's alleged negative narrative against pastoralism. Nevertheless, these results are relatively minor in magnitude, implying that the overall impact of the law on this conflict category is notably limited.

In summary, these results suggest that the AOGLs appear to be ineffective in reducing herder-farmer conflicts, even when these are separated into explicit *herder vs. farmer* conflicts and the category that also encompasses militias and security forces (*herder or farmer related*). This further reinforces the notion that the reported baseline results are not simply artifacts of the selection from the broader sample.

5.2.2 Battles

In the ACLED dataset, the "battles" category typically refers to violent conflicts between two politically organized groups, with at least one being a state or non-state group. In the context of herder-farmer conflicts, battles usually denote incidents where organized herder or farmer groups have engaged in violent clashes. These can range from minor skirmishes over land or resources to larger, more organized incidents involving significant casualties. To examine this conflict category, we extract all "battles" from our total sample and reestimate the baseline specification.

The results in Table 4 indicate a decrease in battles close to the borders relative to the border regions of neighboring states following the implementation of AOGLs (columns 1 and 2). However, we observe a statistically significant increase when we choose a bandwidth of 200 km (columns 7 and 8).

The temporal dynamics of the results, derived exclusively from herder-farmer related battles, are depicted in Figure 6, which compares event studies (including covariates) of the sample with a 25 km bandwidth to those of the sample with a 200 km bandwidth. Close to the border (Subfigure (a)), we find that the decrease of 1.38% reported in column 1 of Table 4 is mainly driven by the coefficients in years 4 and 5 post-law implementation.

We interpret this finding in several ways. On one hand, it may suggest that the effective enforcement of these laws lags several years behind their implementation. On the other hand, this pattern could imply that nomadic herder communities, who may opt for different routes in different years, do not immediately adapt to the law by avoiding the border regions of the treated states, where additional security forces have been allocated by state governors. It is likely that it takes several years for information about the enforcement of AOGLs to disseminate among herder communities. However, this observation also

Table 4: FREQUENCY OF *herder-farmer* CONFLICTS OF THE CATEGORY BATTLES

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0187***	-0.0138***	-0.0116***	-0.0086***	-0.0023	0.0004	0.0031	0.0048**
	(0.0035)	(0.0036)	(0.0023)	(0.0023)	(0.0021)	(0.0022)	(0.0019)	(0.0021)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

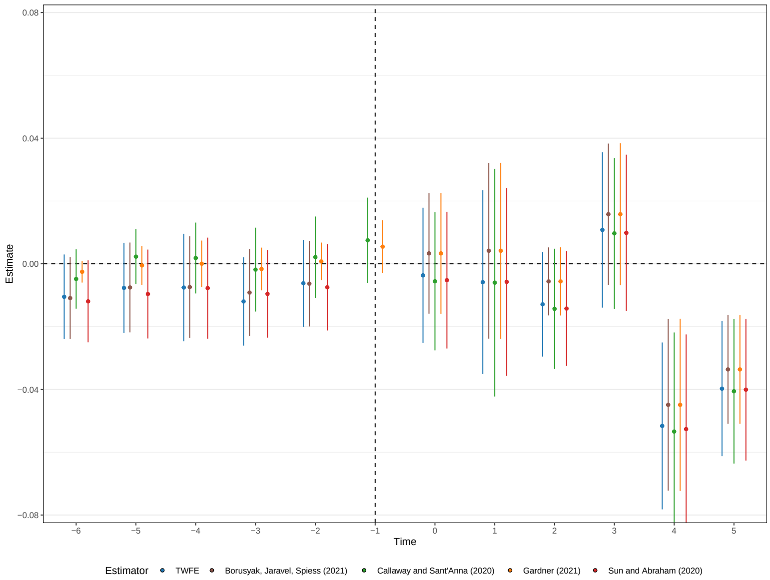
This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflict frequency regions of states that implemented these laws compared to regions in neighboting states. The dependent variable represents the number of herder-farmer conflicts of the category *battles* at the pixel level. Pixel-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the pixel and year levels, to account for potential correlations within individual pixels and over time.

implies that only the early-adopting states (Ekiti, Edo, Benue, Taraba) witness a reduction in battles proximate to their borders, as these states alone define the coefficients from year $t = 4$ onward.

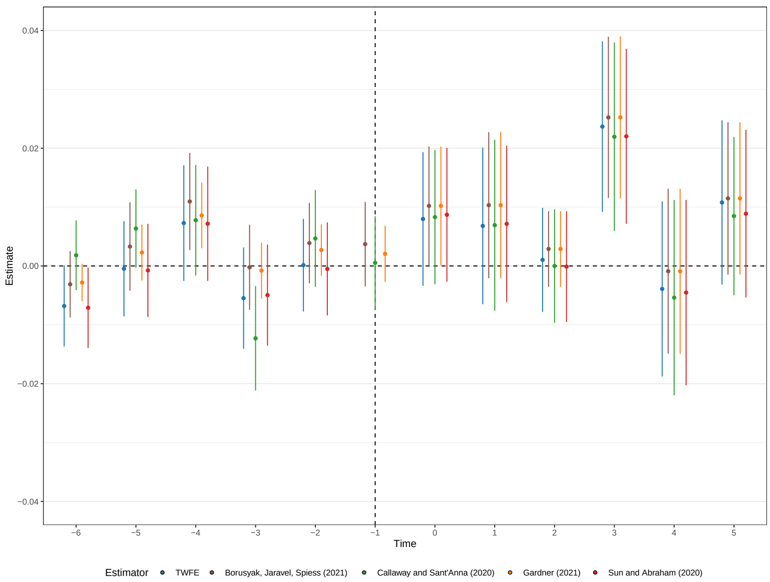
When considering the entire area of treated states in comparison to the area defined by the 200 km radial buffer in neighboring states, Subfigure (b) indicates an upward trend in battles after the enactment of AOGLs, with a surge observed three years post-implementation. These results lend credence to the hypothesis of delayed enforcement and corroborate our primary finding, which suggests that the laws effectively shifted conflicts from border regions of treated states to neighboring states or even to other regions within the treated states themselves.

We also use the second largest category in the conflict data as an outcome variable: “violence against civilians”. The results are displayed in Table A.9 (Appendix). We do not find any statistically significant differences.

The divergent results of the categories battles and violence against civilians post-implementation of Anti-Open Grazing Laws (AOGLs) may be attributed to several factors. First, the enforcement of AOGLs could prompt an increase in structured encounters, reflected in the battles category, without necessarily inducing a surge in violence against non-combatant civilians. Second, the nature of violent events captured by these categories might play a role. Battles often encapsulate planned or large-scale violent episodes, while violence against civilians generally encompasses more spontaneous incidents. The formal, legislative character of AOGLs may, therefore, incite more organized responses by security forces, manifested as battles. Finally, a potential measurement and reporting bias may contribute to the differential outcomes. It is often easier to identify, record, and verify battles involving organized groups than to account for dispersed, sporadic incidents of violence against civilians. Thus, the seeming stability in violence against civilians could be a function of underreporting or verification challenges.



(a) 25 km



(b) 200 km

Figure 6: EVENT-STUDIES: FREQUENCY OF HERDER-FARMER CONFLICTS OF THE CATEGORY BATTLES. This figure presents the event-study plots generated using five different estimators to examine the impact of enactment of Anti-Open Grazing Laws in year $t = 0$ on *herder-farmer* conflicts of the category battles. Figure (a) presents the results with a 25 km bandwidth, while Figure (b) displays the results with a 200 km bandwidth. The estimators utilized include the dynamic version of the TWFE model (blue), Gardner (2022) (red), Sun and Abraham (2021) (red), Callaway and Sant'Anna (2021) (green), Roth and Sant'Anna (2021) (purple), and Borusyak, Jaravel, and Spiess (2021) (brown). These estimates were computed using the *did2s* R package. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Comparison groups were defined by the default settings: not-yet treated and never-treated entities (cells). The x-axis represents time, measured in years, with the vertical reference line indicating the reference period. The y-axis shows the estimates for the conflict variable. The bars on the plot represent 95 percent confidence intervals, with standard errors clustered at the cell level.

A holistic understanding of these conflict dynamics requires an integration of this quantitative analysis with comprehensive qualitative research.

5.2.3 Fatalities

We once again modify the outcome variable of our baseline specification, this time using fatalities as the dependent variable for the estimations. The results are reported in Table 5. The coefficients for all distances are negative and significant, implying a decrease in reported fatalities after the implementation of AOGLs. Moreover, the event studies reveal no systematic differences in pre-trends (7). However, the event studies indicate a higher volatility in the fatality variable after law implementation compared to the estimations with other conflict categories. Therefore, it remains questionable whether the downward trend is sustainable. Furthermore, it may be questioned why reported conflicts remain on a similar or even higher level, while fatalities tend to fall. There are several potential explanations for this finding.

Table 5: FATALITIES OF *herder-farmer* CONFLICTS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0926	-0.0571	-0.1586***	-0.1287**	-0.0891***	-0.0609*	-0.0595**	-0.0557**
	(0.0657)	(0.0758)	(0.0391)	(0.0441)	(0.0263)	(0.0283)	(0.0217)	(0.0231)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects fatalities of herder-farmer conflicts in regions of states that implemented these laws compared to regions in neighboring states. The dependent variable represents the number of herder-farmer conflicts of the category *battles* at the cell level. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the cell and year levels, to account for potential correlations within individual cells and over time.

First, if conflict management and de-escalation strategies have been improved and effectively implemented, this could reduce the number of fatalities without necessarily reducing the number of conflicts. This may be attributable to better-trained peacekeeping forces, community-led initiatives, or government policies that promote peaceful dispute resolution.

Second, improvements in medical facilities and emergency response times - potentially due to the presence of additional security forces - could result in more lives being saved during conflicts, which could decrease fatalities even if the number of conflicts remains constant.

Third, it is also possible that there is an increase in less violent conflicts, such as protests or strikes, that increase the overall number of conflicts but not the number of fatalities. However, given that our data shows battles in the treated states tend to increase following the implementation of laws, we can rule out the idea that more peaceful forms of protest drive these results.

Fourth, an increased presence or effectiveness of law enforcement or peacekeeping forces could prevent conflicts from escalating to the point of causing fatalities. Specifically, it may be the case that more professionally trained security forces are engaging in conflicts.

Finally, the potential for systematic manipulation or misreporting of fatality data within conflict zones, such as those in Nigeria, must be acknowledged. This issue arises largely due to the inherent complexities of accurately obtaining fatality numbers, which present far greater challenges than simply reporting the occurrence of the incidents themselves.[17]

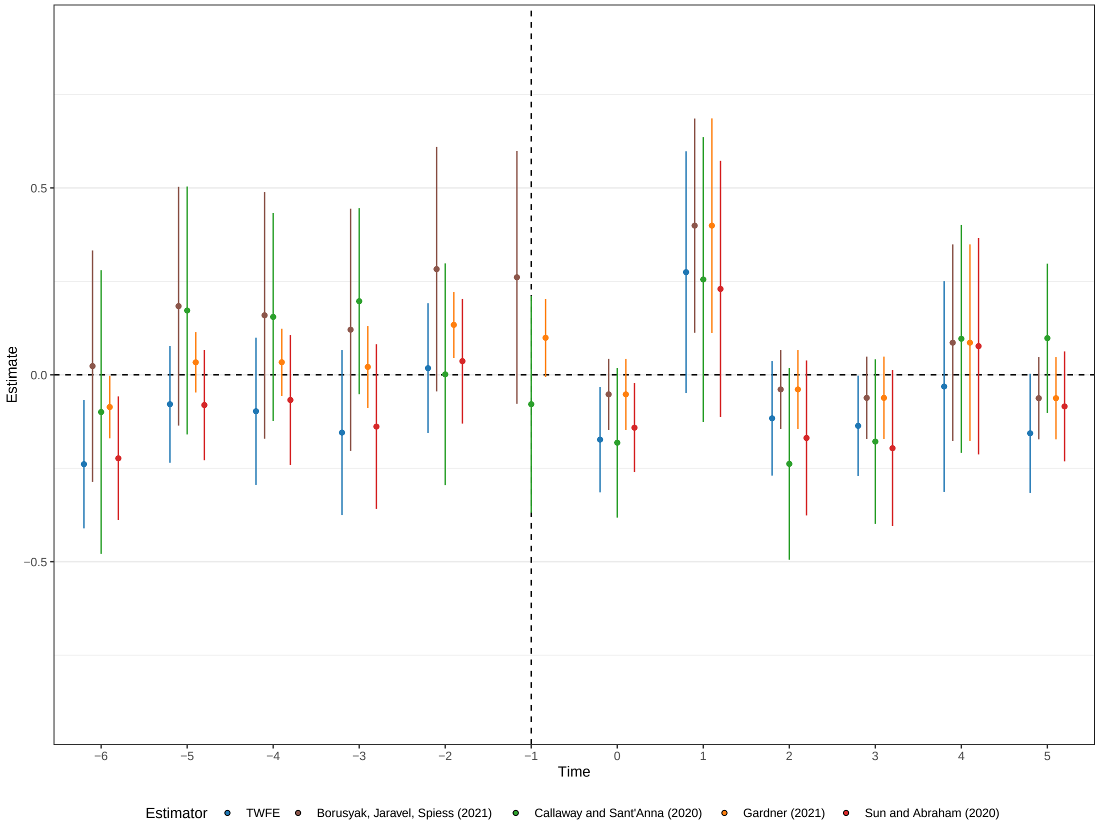


Figure 7: EVENT-STUDY: FATALITIES OF HERDER-FARMER CONFLICTS IN BORDER REGIONS OF TREATED STATES. This figure presents the event-study plots for the sample within a 200 km bandwidth. These results are generated using six different estimators to examine the impact of the enactment of Anti-Open Grazing Laws in year $t = 0$ on fatalities of herder-farmer conflicts. The estimators utilized include the dynamic version of the TWFE model (blue), Gardner (2022) (red), Sun and Abraham (2021) (red), Callaway and Sant'Anna (2021) (green), Roth and Sant'Anna (2021) (purple), and Borusyak, Jaravel, and Spiess (2021) (brown). These estimates were computed using the *did2s* R package. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Comparison groups were defined by the default settings: not-yet treated and never-treated entities (cells). The x-axis represents time, measured in years, with the vertical reference line indicating the reference period. The y-axis shows the estimates for the fatality variable. The bars on the plot represent 95 percent confidence intervals, with standard errors clustered at the cell level.

[17] ACLED data is considered a reliable source for information on conflicts and associated fatalities. However, it is important to note the inherent challenges in collecting accurate data in conflict situations, including access to the conflict zone, potential bias in reporting, underreporting due to fear, and challenges in verification. ACLED mitigates these issues by cross-verifying with multiple sources, including media reports, NGO reports, and other data collection organizations. While this does not entirely eliminate the possibility of errors, it does make the data highly reliable for conflict research. In the specific context of Nigeria, it's crucial to remember that the actual number of fatalities in conflicts can sometimes be obscured or underreported due to various issues, including inaccessible rural locations, societal stigma, or other political factors.

5.2.4 Spillover effects on other violent conflict categories

The goal of the subsequent estimations is to test whether the laws have spillover effects on other conflict categories. We utilize the full sample from the ACLED database across Nigeria for our investigation period (2000-2022) and identify approximately 22,304 violent conflicts after excluding 6,362 identified herder-farmer conflicts. Accordingly, we re-estimate our baseline specification. The results, shown in Table 6, do not indicate any systematic effects. Overall, the AOGLs seem to have little to no spillover effects on conflict categories unrelated to farming or herding groups.

Table 6: FREQUENCY OF OTHER CONFLICTS (EXCLUDING *herder-farmer* CONFLICTS)

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0490	-0.0955***	-0.0273	-0.0705***	-0.0040	-0.0325*	0.0248	-0.0033
	(0.0287)	(0.0293)	(0.0205)	(0.0202)	(0.0166)	(0.0181)	(0.0159)	(0.0155)
Observations	22,269	20,496	34,580	31,762	52,689	48,363	72,540	66,592
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflicts other than herder-farmer in regions of states that implemented these laws compared to regions in neighboring states. The dependent variable represents the occurrence of conflicts that are not coded as *herder-farmer* at the cell level. Cell-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the cell and year levels, to account for potential correlations within individual cells and over time.

5.2.5 Placebo test

Herder-farmer conflicts tend to be more prevalent in rural areas with lower population densities, where disputes over land and water resources are frequent. These conflicts are often reported along the borders of Nigerian states. This is because herders and farmers frequently traverse state lines in search of grazing land and farmland, potentially leading to conflicts with local communities and other groups who possess established rights to the land. Additionally, different states may adopt varying policies and approaches to land management and conflict resolution, contributing to tensions and disputes. Moreover, several rivers serve as natural boundaries between Nigerian states (see Figure A.1). For instance, the Niger River flows through multiple states, including Niger State, Kogi State, and Delta State, while the Benue River acts as a boundary between states such as Benue State and Nasarawa State. Other rivers that serve as state boundaries include the Sokoto River, Cross River, and Kaduna River. These rivers play a significant role in herder-farmer conflicts as they serve as water sources for both groups and can lead to disputes over access and usage. The natural endowments of state border regions, as well as the descriptive evidence presented in Figure 1, indicate that these areas lie at the core of herder-farmer conflicts. Consequently, one might argue that our main finding is merely the result of random chance.

To validate our main finding, which suggests that the laws and their enforcement have resulted in a shift of conflicts from the border regions of treated states to the border regions of neighboring states (see Section 5), we conduct difference-in-differences placebo tests along the borders of non-treated states. The objective of these regressions is to ascertain whether the observed treatment effects are robust or merely a result of random variation. If our primary results were attributed to randomness, assigning treatments arbitrarily to the borders of untreated states should yield similar coefficients. However, if the placebo regressions with randomly assigned treatments yield coefficient estimates close to zero, it would imply that our original estimates are associated with a decrease relative to the borders of neighboring states.

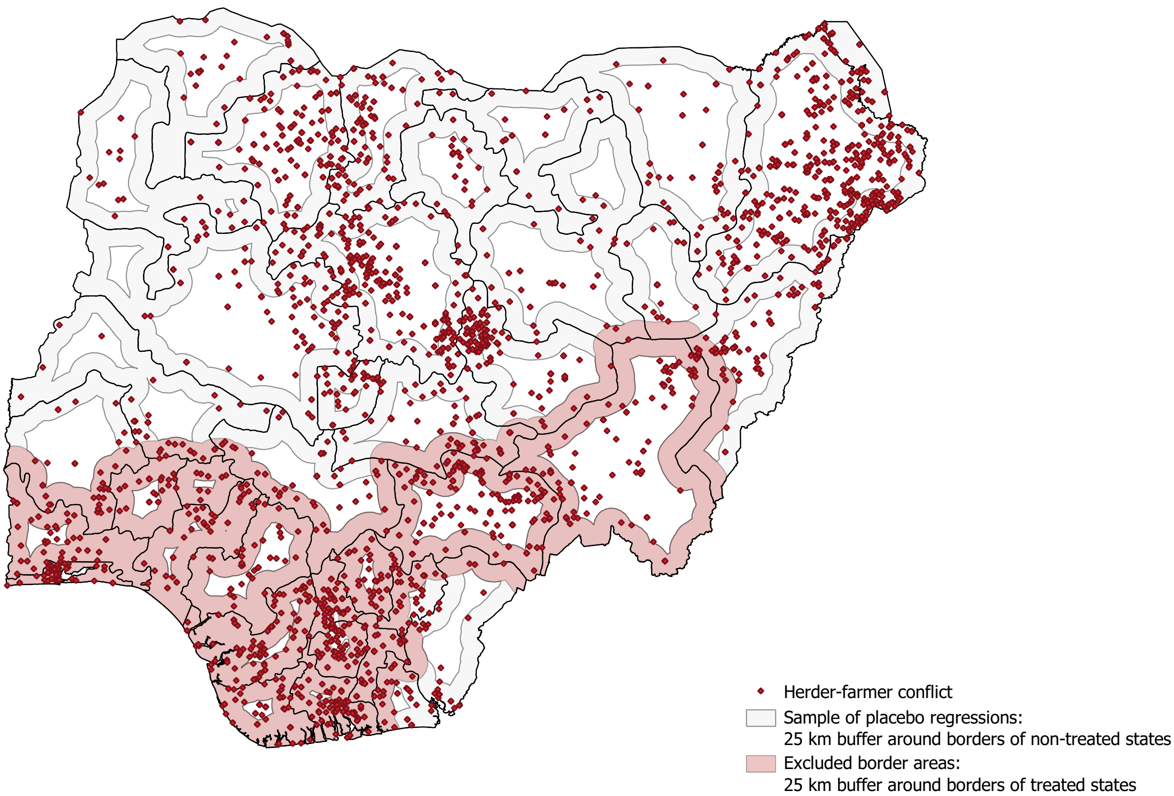


Figure 8: DESIGN OF THE PLACEBO TEST. This figure shows a political map of Nigeria at the tier 1 level. The red dots indicate the locations of all 6,362 herder-farmer conflicts that we identified in the ACLED dataset. The grey shaded areas represent the border regions of Nigerian states, while the red shaded areas indicate the border regions around treated states (excluded from placebo analysis).

To construct the placebo sample, we initially identify all areas (cells) within Nigeria that fall within a 25 km radial buffer around state borders. Subsequently, we exclude the defined border regions around treated states (as depicted by the red shaded area in Figure 8). To replicate the staggered implementation of the laws, we randomly select one state from this reduced sample for the year 2016, three states for the year 2017, one state for the year 2018, and eight states for the year 2021. These selected states are then assigned placebo treatments. Next, we re-estimate the baseline model using the methodology proposed by Sun and Abraham (2021). This process is repeated 1,000 times, and the cumulative distribution of the estimated coefficients is presented in Figure A.9 (Appendix).

Our analysis reveals that the placebo estimates for conflict spread are centered around zero, providing additional evidence of the robustness of our baseline results for this category. Furthermore, less than 10% of the placebo coefficients exhibit a magnitude similar to the treatment effects observed for conflict spread in the original sample (-1.68%). This finding suggests that the reduction in conflict spread can indeed be attributed to the law or its enforcement, further reinforcing the notion that the observed shift in conflicts is not merely a result of random chance.

6 Conclusion

In conclusion, this study sheds light on the implications of political intervention on herder-farmer conflicts in Nigeria. The findings suggest that the Anti-Open Grazing Laws implemented by several Nigerian states over the past few years have been inadequate in reducing these conflicts. In fact, our analysis indicates that the implementation of these laws may have even led to increased tensions in subsequent years, particularly in the border regions neighboring other states. While there may be some positive effects in reducing conflicts in the border regions of treated states compared to neighboring states, the overall impact of the laws remains mixed.

The results of our study imply that alternative formal institutions need to be implemented to effectively address the rise of herder-farmer conflicts in Nigeria. These findings are important for policymakers to reconsider their approach to resolving herder-farmer conflicts and managing increasingly scarce land resources.

In addition to the policy implications, it is crucial to consider the broader context in which herder-farmer conflicts occur. Climate change is expected to intensify the frequency and severity of droughts and other extreme weather events in many regions, which could further exacerbate the competition for limited resources like water and land. Therefore, it is likely that herder-farmer conflicts will continue to pose a significant challenge in Nigeria and other parts of Africa in the future. Further research is needed to gain a deeper understanding of the complex dynamics underlying these conflicts and to identify effective strategies for their mitigation.

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Appendix

A.1 Identification of herder and farmer related conflicts

We carefully identify herder-farmer conflicts through manual desk research, as several violent groups exploit the guise of the farmer-herder conflict to perpetrate violence. To isolate conflicts directly linked to the herder-farmer crisis, we remove all religious and ethnic conflicts from our analysis. For example, on January 5, 2023, the Obudu Communal group and the Tiv ethnic militia clashed along the Vande Ikya - Obudu road (ACLED). Although media reports labeled it as a herder-farmer conflict due to the ethnic identities of the Tivs and Obudu as pastoralists and farmers, there was no evidence indicating that the parties involved were farmers or pastoralists.

However, it has become evident that pastoralism and the activities of pastoralists lie at the core of many herder-farmer conflicts in West Africa. Understanding the conflict within the context of pastoralism, rather than solely as a farmer-herder conflict, may provide a lens for analyzing the conflict. During reprisal attacks by herder militias or even by the pastoralists themselves, conflicts and fatalities can arise when they encounter state security forces or local vigilante groups such as Amotekun. For instance, on April 4, 2022, soldiers and Amotekun operatives clashed in the Oke Aro area of Akure (Akure South, Ondo) after a dispute related to cattle grazing. The conflict resulted in multiple casualties and deaths, and two Amotekun operatives were arrested by federal military personnel (ACLED). Although this conflict does not directly involve farmers or herders, it appears to have been induced by the farmer-herder crisis. Therefore, to ensure consistency, we utilize two additional types of variables to measure herder-farmer conflicts.

First, we include all conflicts directly related to the herder-farmer crisis, regardless of whether the actors involved were farmers or herders. In our empirical design, we classify this category as *herder or farmer related* conflict (4,628 identified conflicts). This category also encompasses events where state actors or private security forces (such as the Amotekun group) were involved.

Second, we further specify herder-farmer conflicts by isolating those that specifically involved farmers and herders only. According to the ACLED data description, the conflict parties are labeled as "actor 1" or "actor 2". Therefore, we identify herder-farmer conflicts as those conflicts listed in ACLED where both "actor 1" and "actor 2" consist of either farmers or pastoralists. In our empirical analysis, we refer to this group as *herder vs. farmer* (1,848 identified conflicts). Below, we provide some exemplary descriptions of our coding.

- **Unidentified Armed Group (Nigeria):** This group is often implicated in attacks on farmers, typically originating from conflicts between herders and farmers. The herders, unlike organized militias such as Boko Haram - Jamaatu Ahli is-Sunnah lid-Dawati wal-Jihad, are not regarded as an identified armed group. Therefore, conflicts involving this group and farmers (actor_2) are usually understood as confrontations between herders and farmers.

- **Katsina, Zamfara, Kaduna Communal Militias (KCM):** The conflicts between these Communal Militias and other actors (usually herders) are interpreted in this study as conflicts between security forces and herders. These Communal Militias consist of local hunters and vigilante groups who oppose local cattle rustlers and violent herders. They are thus viewed here as security forces. Frequently, these communal militias emerge due to the failure of state security forces to protect the communities from attacks by herders and the Boko Haram group.

- **Fulani Ethnic Militia:** Conflicts involving this group are understood as farmer-herder conflicts. Contrary to the communal militias, the Fulani Ethnic Militia essentially represents the armed faction of the herders and is often involved in confrontations with farmers in various states.

- **Labour Group:** Conflicts featuring the Labour Group are in many cases coded as farmer-herder conflicts, as the Labour Group is the overarching association of organized large- and medium-sized farmers.

- **Man O' War:** This group is a recognized para-military organization in Nigeria. Despite not being armed, they are heavily involved in information gathering for the armed security forces. Clashes involving Man O' War and herders or farmers are classified as herder-security force conflicts.

- **IPOB (Indigenous Peoples of Biafra):** This non-military association, predominantly comprised of farmers in southeast Nigeria, often engages in reprisal attacks against herders who damage farmlands. During these reprisals, they often face confrontations with state security forces, leading to conflict situations.

- **Boko Haram - Jamaatu Ahli is-Sunnah lid-Dawati wal-Jihad:** This group is notorious for a series of major terrorist attacks, including numerous bombings in Nigeria. However, members and defectors from this group often engage in cattle rustling and theft of harvests from farmers. These actions frequently lead to forceful confrontations with state security forces and vigilante groups. Such conflicts are in our view pastoralist conflict and hence we do not code such events as *herder vs. farmer* conflicts but as *herder or farmer related* conflicts.

A.2 Figures and tables

Figure A.1: STATES OF NIGERIA. This map of Nigeria displays its 36 states, the Federal Capital Territory, and the main rivers of the country. Source: https://en.wikipedia.org

Table A.1: SUMMARY STATISTICS

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Conflicts	121394	0.049	0.481	0	32
Population	102289	24765.984	68220.134	16.535	3403723.25
Luminosity	111588	0.952	4.095	0	62.861
Precipitation	111588	3.098	8.898	0	207.436
NDVI	120814	0.709	0.05	0.522	0.881
APC governed area	121309	0.48	0.5	0	1
PDP governed area	121309	0.52	0.5	0	1
Distance to water body	9334	17.957	14.026	0	82.486
Distance to police station	9334	84.263	76.181	0.384	446.942
Distance to security forces	9334	268.015	182.524	2.059	831.233
Distance to church	9334	86.974	60.079	0.205	322.418
Distance to mosque	9334	102.149	70.78	0.192	365.254

Notes: This table presents summary statistics for the total sample. The reported values are averages calculated at the cell-level for the period 2010-2022 (see Section 3). Distances are given in km.

Table A.2: SUMMARY STATISTICS: CONTROL VS. TREATED STATES

Group		Control			Treated	
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**
Conflicts	92495	0.05	0.502	28899	0.048	0.408
Population	77979	20690.594	44869.708	24310	37838.582	113581.601
Luminosity	85068	0.43	2.477	26520	2.627	6.87
Precipitation	85068	1.134	3.754	26520	9.396	15.359
NDVI	92145	0.697	0.046	28669	0.749	0.041
APC governed area	92410	0.524	0.499	28899	0.338	0.473
PDP governed area	92410	0.476	0.499	28899	0.662	0.473
Distance to water body	7111	16.924	13.243	2223	21.263	15.836
Distance to police station	7111	97.43	81.77	2223	42.143	25.529
Distance to security forces	7111	289.976	191.812	2223	197.765	125.395
Distance to church	7111	89.074	55.454	2223	80.257	72.538
Distance to mosque	7111	94.29	59.217	2223	127.289	94.825

Notes: This table presents summary statistics that compare relevant variables between treated and control cells. The reported values are averages calculated at the cell-level for the period 2010-2022 (see Section 3). Distances are given in km.

Table A.3: SUMMARY STATISTICS: CONTROL VS. TREATED STATES (50KM RADIAL BUFFER)

Group		Control			Treated	
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**
Conflicts	16380	0.034	0.29	16341	0.052	0.465
Population	13816	34456.866	65825.559	13728	34317.646	48871.969
Luminosity	15072	0.953	3.766	14976	1.982	6.015
Precipitation	15072	4.466	6.784	14976	6.326	9.692
NDVI	16328	0.737	0.034	16222	0.747	0.038
APC governed area	16380	0.465	0.499	16341	0.359	0.48
PDP governed area	16380	0.535	0.499	16341	0.641	0.48
Distance to water body	1260	19.603	14.595	1257	21.193	16.143
Distance to police station	1260	42.916	24.426	1257	44.795	26.865
Distance to security forces	1260	194.608	138.614	1257	190.816	131.045
Distance to church	1260	57.815	43.97	1257	69.125	58.767
Distance to mosque	1260	107.628	64.586	1257	126.166	79.324

Notes: This table presents summary statistics that compare relevant variables between treated and control cells. All cell centroids fall within a 50 km radial buffer surrounding the borders of the treated states. The reported values are averages calculated at the cell-level for the period 2010-2022 (see Section 3). Distances are given in km.

Table A.4: SUMMARY STATISTICS: CONTROL VS. TREATED STATES (100KM RADIAL BUFFER)

Group		Control			Treated	
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**
Conflicts	27053	0.028	0.258	24648	0.052	0.433
Population	22781	27206.446	55073.023	20724	41086.619	121512.868
Luminosity	24852	0.698	3.105	22608	2.381	6.691
Precipitation	24852	3.567	6.208	22608	7.848	12.35
NDVI	26923	0.733	0.035	24482	0.748	0.039
APC governed area	27053	0.462	0.499	24648	0.36	0.48
PDP governed area	27053	0.538	0.499	24648	0.64	0.48
Distance to water body	2081	19.48	13.874	1896	21.145	15.704
Distance to police station	2081	42.77	23.535	1896	42.22	26.215
Distance to security forces	2081	205.699	146.463	1896	195.33	128.204
Distance to church	2081	58.229	39.689	1896	77.299	69.207
Distance to mosque	2081	98.816	61.751	1896	127.602	90.84

Notes: This table presents summary statistics that compare relevant variables between treated and control cells. All cell centroids fall within a 100 km radial buffer surrounding the borders of the treated states. The reported values are averages calculated at the cell-level for the period 2010-2022 (see Section 3). Distances are given in km.

Table A.5: SUMMARY STATISTICS: CONTROL VS. TREATED STATES (200KM RADIAL BUFFER)

Group		**Control**			**Treated**	
Variable	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**
Conflicts	43680	0.035	0.344	28899	0.048	0.408
Population	36817	22832.384	46910.494	24310	37838.582	113581.601
Luminosity	40164	0.627	3.139	26520	2.627	6.87
Precipitation	40164	2.38	5.183	26520	9.396	15.359
NDVI	43511	0.725	0.036	28669	0.749	0.041
APC governed area	43680	0.492	0.5	28899	0.338	0.473
PDP governed area	43680	0.508	0.5	28899	0.662	0.473
Distance to water body	3360	19.492	13.781	2223	21.263	15.836
Distance to police station	3360	50.708	31.499	2223	42.143	25.529
Distance to security forces	3360	222.835	159.048	2223	197.765	125.395
Distance to church	3360	64.455	39.446	2223	80.257	72.538
Distance to mosque	3360	92.381	56.16	2223	127.289	94.825

Notes: This table presents summary statistics that compare relevant variables between treated and control cells. All cell centroids fall within a 100 km radial buffer surrounding the borders of the treated states. The reported values are averages calculated at the cell-level for the period 2010-2022 (see Section 3). Distances are given in km.

Table A.6: CROSS-SECTIONAL ESTIMATIONS AROUND THE BORDERS OF TREATED STATES

	2015		2022		2022-2015	
	(1)	(2)	(3)	(4)	(4)	(6)
AOGL	0.024***	0.006	-0.008	-0.031**	-0.032***	-0.037**
	(0.006)	(0.007)	(0.011)	(0.015)	(0.011)	(0.015)
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular
Bandwidth (km)	200/200	200/200	200/200	200/200	200/200	200/200
Observations	3176/2039	3176/2039	3176/2039	3176/2039	3176/2039	3176/2039
Polynomial order	1	2	1	2	1	2

Notes: This table collects the results of the cross-sectional estimations around the borders of treated states, as illustrated in Figure 4. The results were obtained using the *rdrobust* R-package. Stars indicate significance levels at 10%(*), 5%(**) and 1%(***). Conventional standard errors in parentheses.

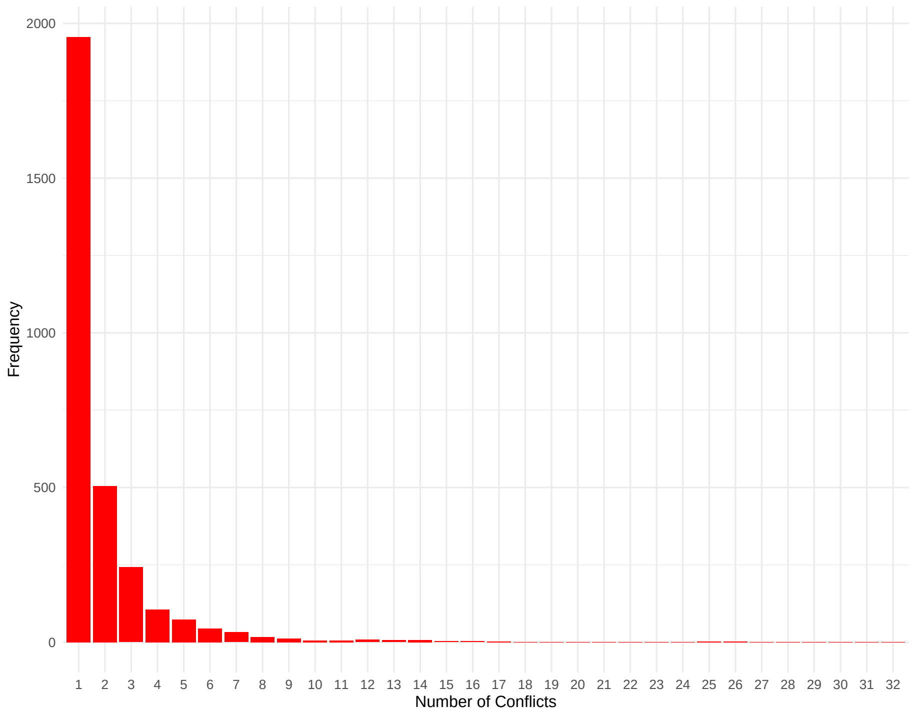

Figure A.2: CELL-LEVEL CONFLICT COUNTS. This figure shows the counts of herder-farmer conflicts at the cell level for all cells that have recorded one conflict or more. Approximately 64% of these cells have recorded a single conflict, while about 90% have recorded five conflicts or fewer.

Table A.7: FREQUENCY OF *herder-farmer* CONFLICTS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	-0.0169	-0.0070	-0.0170**	-0.0097	-0.0085	0.0005	-0.0010	0.0055
	(0.0138)	(0.0165)	(0.0076)	(0.0090)	(0.0054)	(0.0065)	(0.0047)	(0.0059)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table compiles the results of the Sun and Abraham (2021) specification with incrementally increasing radial buffers. We investigate whether the enactment of Anti-Open Grazing Laws affects conflict frequency regions of states that implemented these laws compared to neighboring states. The dependent variable represents the number of herder-farmer conflicts at the pixel level. Pixel-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the pixel and year levels, to account for potential correlations within individual pixels and over time.

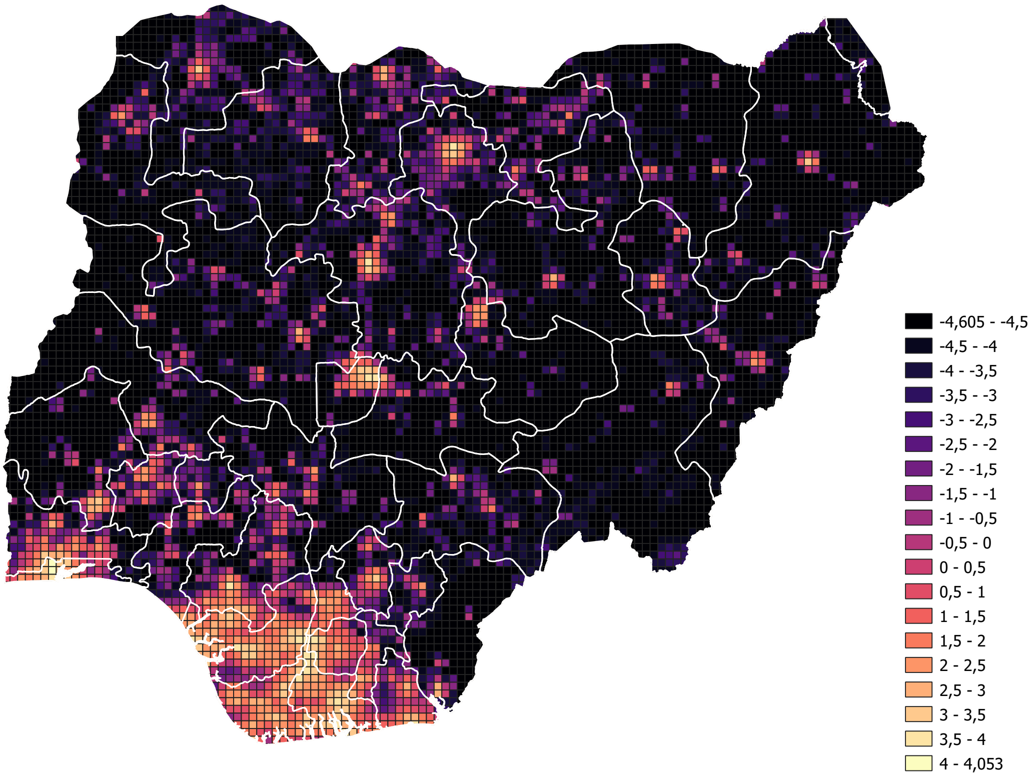

Figure A.3: NIGHT LIGHT INTENSITY AT THE CELL-LEVEL. This figure displays the logarithm of the mean night light output for the period from 2000 to 2022. The cell values were computed by extracting information from the night light raster files based on the grid of Nigeria that we use in our empirical analysis. This process was conducted using the *exactextractr* R package. Cells with greater brightness indicate higher nighttime light intensity. The corresponding values are tabulated in the legend.

Table A.8: FREQUENCY OF *herder-farmer* CONFLICTS (TOTAL SAMPLE)

	(1)	(2)
AOGL	-0.0016	0.0001
	(0.0048)	(0.0056)
Observations	121,394	111,520
Controls		✓
Cell FE	✓	✓
Year FE	✓	✓

This table collects results of the Sun and Abraham (2021) specification using the total sample. We study whether enactments of Anti-Grazing Laws lead to an increase of conflicts in cells falling within states that implemented these laws compared to all other areas (cells) across Nigeria. The dependent variable represents the number of herder-farmer conflicts. Pixel-level controls include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 for PDP and 0 for APC or any other party. Stars denote significance levels at 10%(*), 5%(**), and 1%(***). Heteroscedasticity- and cluster-robust standard errors are shown in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the pixel and year levels, to account for potential correlations within individual pixels and over time.

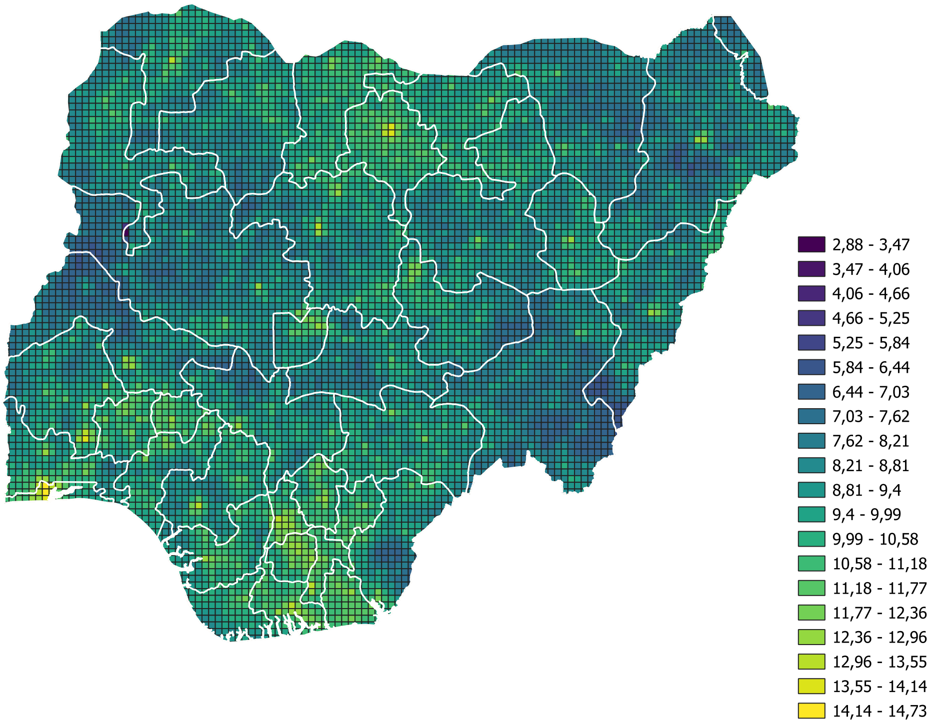

Figure A.4: POPULATION AT THE CELL-LEVEL. This figure displays the logarithm of mean population for the period from 2000 to 2022. The cell values were computed by extracting information from the WorldPop population raster files based on the grid of Nigeria that we use in our empirical analysis. This process was conducted using the *exactextractr* R package. The corresponding values are tabulated in the legend.

Table A.9: FREQUENCY OF *herder-farmer* CONFLICTS OF THE CATEGORY VIOLENCE AGAINST CIVILIANS

	25km		50km		100km		200km	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AOGL	0.0056	0.0112	-0.0027	0.0025	-0.0060	0.0009	-0.0041	0.0012
	(0.0099)	(0.0124)	(0.0051)	(0.0065)	(0.0035)	(0.0045)	(0.0031)	(0.0040)
Observations	20,943	19,272	32,721	30,046	51,701	47,451	72,579	66,628
Controls		✓		✓		✓		✓
Cell FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓

This table collects the results of the Sun and Abraham (2021) specification with increasing radial buffers. We study whether enactments of Anti-Open Grazing Laws affect conflicts in border regions of states that implemented these compared to neighboring states. The binary dependent variable captures the occurrence of conflicts at the pixel level. Controls at the pixel-level include the mean values of yearly nightlight output and vegetation (NDVI), as well as a dummy variable indicating the governor's party affiliation, with a value of 1 representing PDP and 0 representing APC or another party. Stars indicate significance levels at 10%(*), 5%(**) and 1%(***). Heteroscedasticity- and cluster-robust standard errors in parentheses. Specifically, we employ two-way clustered standard errors, clustering at the pixel and year levels, to account for potential correlations within individual pixels and across time.

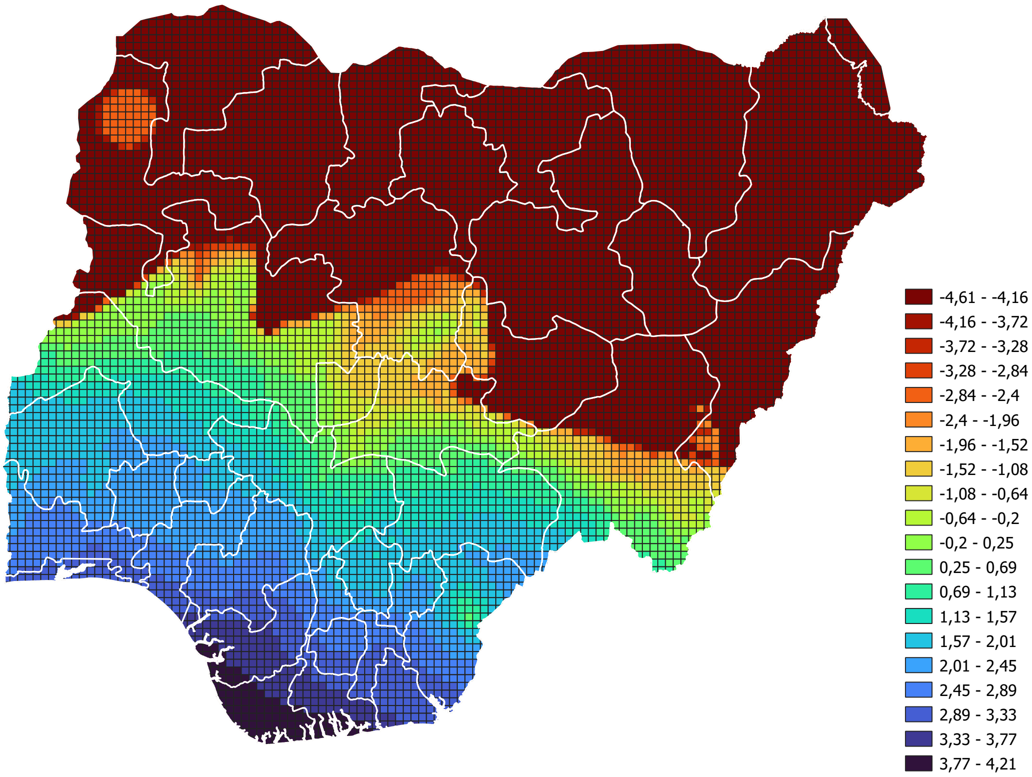

Figure A.5: PRECIPITATION AT THE CELL-LEVEL. This figure displays the logarithm of mean precipitation for the period from 2000 to 2022. The cell values were computed by extracting information from the TerraClimate precipitation raster files based on the grid of Nigeria that we use in our empirical analysis. This process was conducted using the *exactextractr* R package. The corresponding values are tabulated in the legend.

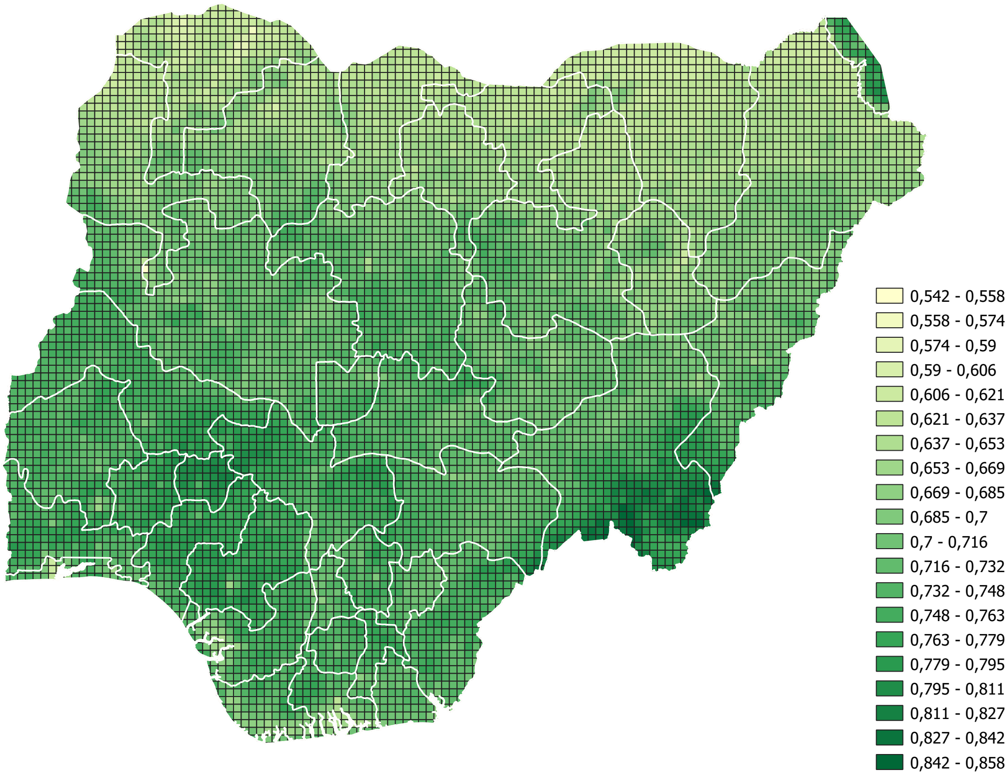

Figure A.6: VEGETATION AT THE CELL-LEVEL. This figure shows the mean of the Normalized Difference Vegetation Index (NDVI) for the period from 2000 to 2022. The cell values were computed by extracting information from the MODIS vegetation raster files based on the grid of Nigeria that we use in our empirical analysis. This process was conducted using the *exactextractr* R package. The corresponding values are tabulated in the legend.

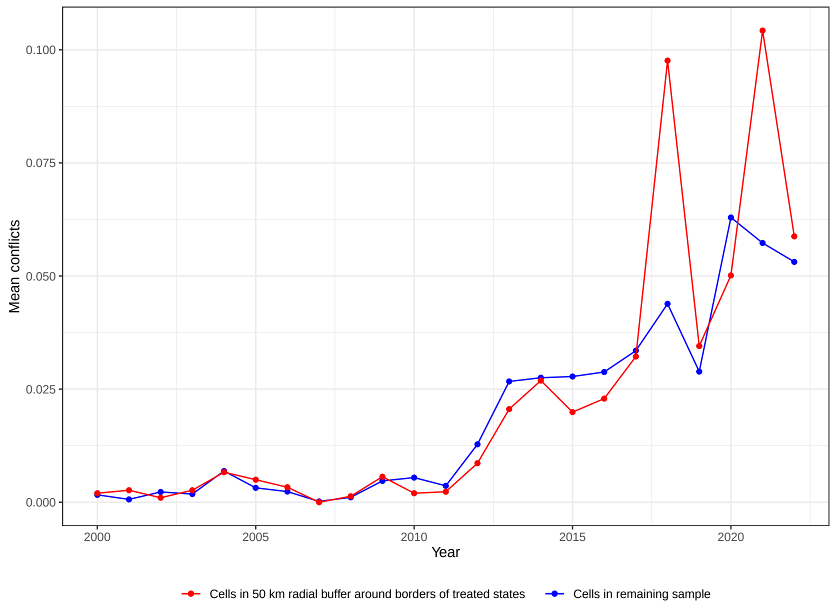

Figure A.7: DEVELOPMENT OF IDENTIFIED HERDER-FARMER RELATED CONFLICTS OVER TIME (2000-2022): BORDER REGIONS AROUND TREATED STATES VS. REMAINING COUNTRY. This figure compares development of mean herder-farmer related conflicts between border regions that fall within a 50 km radial buffer around borders of treated states with cells in the remaining country.

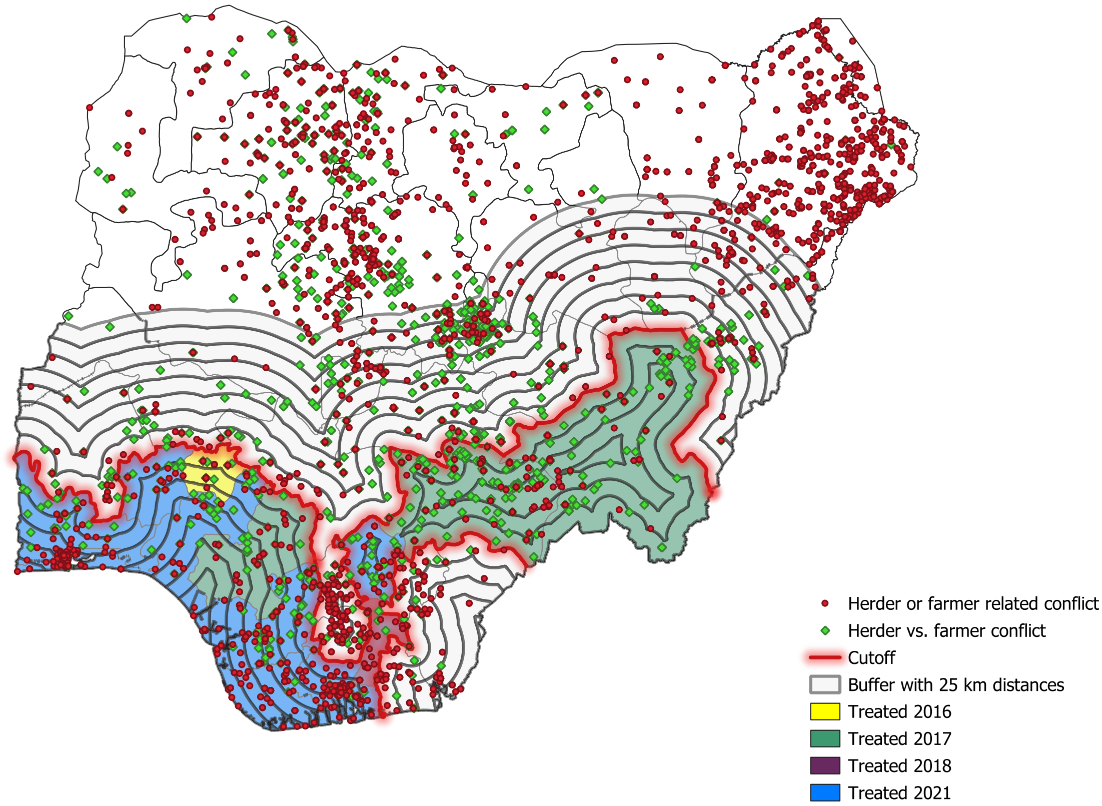

Figure A.8: GEOGRAPHICAL DESIGN OF THE BASELINE SPECIFICATION BY HERDER-FARMER CONFLICT CATEGORY. This figure presents a political map of Nigeria at the tier 1 level. The red dots mark the locations of *herder or farmer related* conflicts that we identified in the ACLED dataset. The green dots denote the locations of *herder vs. farmer* conflicts. The green dots indicate the location of *herder vs farmer* conflicts. The colored areas as reported in the legend represent the treated states and the respective years of law implementation. The 25 km buffers indicate the distances for the treatment and control assignment of our baseline specification. The underlying grid of cells is not displayed for simplicity reasons.

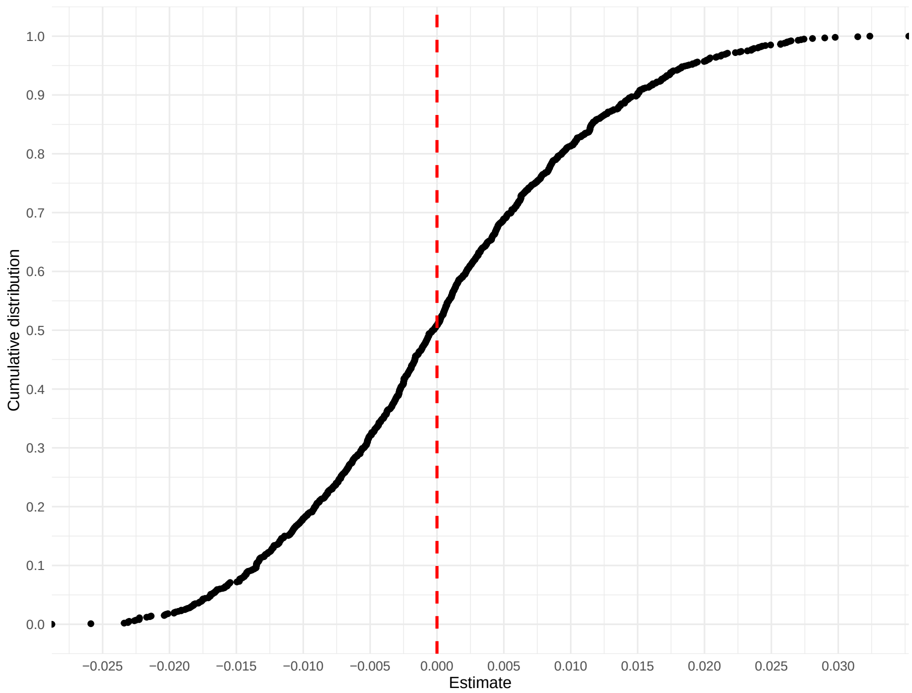

Figure A.9: PLACEBO REGRESSIONS: CONFLICT SPREAD. This figure collects placebo regressions results regarding the effect of the laws on conflict spread. For this, we rely on a sample that excludes the border areas around treated states, as defined by a 25 km radial buffer. Within this sample of 23 originally untreated states, we randomly assign 13 states with staggered timing to the treatment group and re-estimate the regressions reported in Table 1, column 1. We estimate 1,000 such placebo regressions and plot the cumulative distribution of the coefficient estimates (black dots) in the above figure.