

The Effect of Farmer-Pastoralist Violence on State-level Internal Revenue Generation in Nigeria

A Modified Synthetic Control Analysis Approach

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Abstract

Nigeria's ethnically and religiously diverse Middle Belt has experienced recurrent eruptions of violence over the past several decades. Disputes between pastoralists and farmers arise from disagreements over access to farmland, grazing areas, stock routes, and water points for both animals and households. Although relatively low in intensity, this form of violence is widespread, persistent, and arguably increasing in its incidence. This study seeks to answer the question: How has farmer-pastoralist conflict affected state internally-generated revenues (IGR)? The literature on the effect of violence on sub-national fiscal capacity is slim to none. We use a synthetic control approach to model how IGR for four conflict-affected states – Benue, Kaduna, Nasarawa, and Plateau – would have developed in the absence of violence. To account for the endogeneity criticism commonly leveled at such synthetic control analyses, we then use a fixed-effects IV model to estimate IGR losses predicted by the synthetic control analysis as a function of farmer-pastoralist fatalities. Our conservative estimates for percentage reduction to annual state IGR growth for the four states are 0%, 1.2%, 2.6%, and 12.1% respectively, implying that IGR is likely much more sensitive to conflict than GDP. In total, the four study states of Benue, Kaduna, Nasarawa, and Plateau are estimated to have lost between US\$719 million and US\$2.3 million in 2010, or 22-47% of their potential IGR collection during the period of intense violence.

JEL Classification Codes: C15, C36, D74, H71.

Introduction

This study seeks to answer the question: How has farmer-pastoralist conflict affected state government revenues (IGR) in Nigeria’s Middle Belt? This is just one component of the broader costs of farmer-pastoralist conflict in Africa’s largest economy¹. Such farmer-pastoralist conflicts are commonplace across the West African Sahel, and may generally exacerbate religious conflict, as farmers there tend to be Christian and pastoralists Muslim. This study in particular is geared toward generating greater awareness among local politicians and external actors of the importance of this phenomenon – often overshadowed by Islamist extremism in the Northeast and violence related to oil extraction in the Niger Delta region. Whilst a small body of literature has considered the effect of violent conflict on fiscal capacity (e.g., Chowdhury & Murshed, 2013), to the authors’ knowledge, no study has looked at non-civil war violence as a predictor, chosen a sub-national unit of analysis, or used synthetic control analysis to model hypothetical, alternative IGR “histories” under the assumption of peace. In all these ways, this study is unique.

Background

Nigeria’s ethnically and religiously diverse Middle Belt has experienced recurrent eruptions of violence over the past several decades. Disputes between pastoralists and farmers arise from disagreements over the use of land around farmland and/or grazing areas and stock routes and access to water points for both animals and households. A range of factors underlie these disputes, including increased competition for land (driven by desertification, climate change, and population growth), lack of clarity around the demarcation of pasture and stock routes, and the breakdown of traditional relationships and formal agreements between pastoralists and farmers. These conflicts undermine market development and economic growth by destroying productive assets, reducing production, preventing trade, deterring investment by private sector actors, and eroding trust and social cohesion. Because livelihood strategies in Nigeria are closely tied to identity and because access to services and opportunities can vary across identity groups, many pastoralist/farmer conflicts take on ethnic and religious hues and are exacerbated along identity lines. These conflicts undermine market development and economic growth by destroying productive assets, reducing production, preventing trade, deterring investment by private sector actors, and eroding social cohesion.

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Methods

Nigerian states receive revenue in two main ways: taxes collected within the state and disbursements from the federal government (much of which is derived from oil revenues). There are other economic and peace and conflict dynamics that affect oil revenues and disbursements, which are outside the scope of this study. As such, we focus on internally generated revenue (IGR) in order to measure the effects of farmer-pastoralist conflict at the state level.

We examine IGR for two reasons. First, we find it to be a suitable proxy for gross domestic product on the Nigerian state level, or, gross state product. Measurements of economic growth in terms of product are not available on the state level, however we can assume that trends in IGR mirror, to some extent, trends in gross state product. As such, measuring the effect of conflict on IGR provides a picture of the impact of conflict on the state-level economy and an indication of the effect of conflict on the trend line of gross state product. Second, we expect that this information will be most relevant to policymakers. To the extent that policymakers in the four targeted Middle Belt states have the opportunity to positively transform the farmer-pastoralist conflict, measurements of the economic impacts of this conflict on the state level economy provide an economic incentive for doing so.

The purpose of synthetic modeling analysis is to construct a hypothetical counterfactual scenario that may or may not obtain under any believable set of real-world circumstances. In effect, this research question asks: “How would the local economies of the four target states have performed differently if the recent dramatic rises in farmer-pastoralist violence had never occurred?” The hypothetical counterfactual history can then be compared to the actual economic performance in the actual (conflict-affected) area.² This is a hypothetical *retrospective* question, and is thus different from a hypothetical *prospective* question along the lines of: “How would the local economy perform differently in the future if acts of farmer-pastoralist violence stopped occurring now?”

Taking this as a starting point, the proposed approach employs a synthetic modeling strategy to construct a hypothetical counterfactual in which rises in farmer-pastoralist violence never occurred. It does this by using longitudinal (i.e., time-series) measurements of IGR in similar states that have not experienced (much) farmer-pastoralist violence to estimate a model of a community that has, but only up until the point at which violence erupted. The states used as predictors may be selected on the basis of some matching algorithm (e.g., factor analysis or Coarsened Exact Matching (CEM)): this technique roughly pairs up “treatment” and “control” states. Once the model is parameterized in this way, it is used to predict later hypothetical values of IGR in the violence-affected state. These values represent the model’s best estimate of IGR in the community, had violence never occurred. In practical terms, this approach requires a

² One prominent example of this methodology in assessing the costs of conflict is Abadie and Gardeazabal (2003). For a more general note, see Abadie, Diamond, and Hainmueller (2010).

relatively long time-series of income measures in both control and treatment states. During the preparation for this report, MC obtained CBN-published annual reports on the Nigerian economy from NBS dating back to 1980.

The most common criticism of the synthetic modeling approach is that the (control) territorial units employed in the statistical construction of the hypothetical counterfactual may differ fundamentally in unobserved ways from the study (treatment) area (Skaperdas, Soares, Willman, & Miller, 2009, p. 6). In other words, economic performance and violent conflict are highly endogenous (i.e., interrelated) phenomena. It is possible that Nigerian states that experienced dramatic rises in farmer-pastoralist violence also had economies that performed more poorly in some fashion, thereby shaping the very structural conditions that led to violence in the first place. However, the best-case scenario controls for endogeneity are incompatible with either the synthetic control analysis or our available data. An econometric estimator that would effectively control for endogeneity (e.g., a fixed-effects (FE) instrumental variable estimator) would not address itself to the proposed target states exclusively, as it would require more observations, and would certainly not be capable of addressing the economic losses from each state on an individual basis. Furthermore, an estimator such as the Arellano-Bond GMM is designed for many observations and short time panels, rather than the reverse (our case). Finally, a FE IV regression is unable to recreate a counter-factual history of the state's finances, as the synthetic approach does.

Therefore, in order to minimize the endogeneity concern, we have decided to use a FE IV model in post-estimation to assess the losses to IGR that we predict using the synthetic analysis. We then use a Population Attributable Fraction post-estimation analysis to quantify the percentage of the predicted IGR losses that we can causally attribute to farmer-pastoralist violence. We thus attempt to combine the best of both worlds.

Violence Dataset Creation

Our analysis requires two datasets of violent events in Nigeria, both constructed using the UCDP Georeferenced Event Dataset (GED) and the ACLED dataset for Nigeria for all available years. UCDP covers the period 1990-2010, while ACLED covers the period 1997-present. We first created a national dataset of all violent events with at least one fatality, during all conflicts, by appending the ACLED and UCDP datasets; we then collapsed this dataset by month to obtain monthly totals of violent-event related fatalities for each state from 1990 to 2013. This national dataset of monthly fatalities by state allows us to determine relative levels of violence, in order to identify comparatively peaceful predictor states for the synthetic control region.

We then constructed a dataset of just violent events related to farmer-pastoralist conflict in our four study states, for use in the regression analysis detailed below. It is difficult to definitively classify any violent event as being associated specifically with farmer-pastoralist violence. Accordingly, it is equally difficult to establish a time at which any given state began

experiencing such violence. We have attempted to create an authoritative dataset on farmer-pastoralist violence from ACLED and UCDP sources by applying the inclusion and exclusion criteria for farmer-pastoralist violent conflict events listed in Appendix A. This included dropping out events (observations) that involved actors deemed not directly associated with such farmer-pastoralist clashes (e.g., acts claimed by Boko Haram, more properly known as Jama'atu Ahlul Sunnah Lih Da'awa wal Jihad (JAS)).

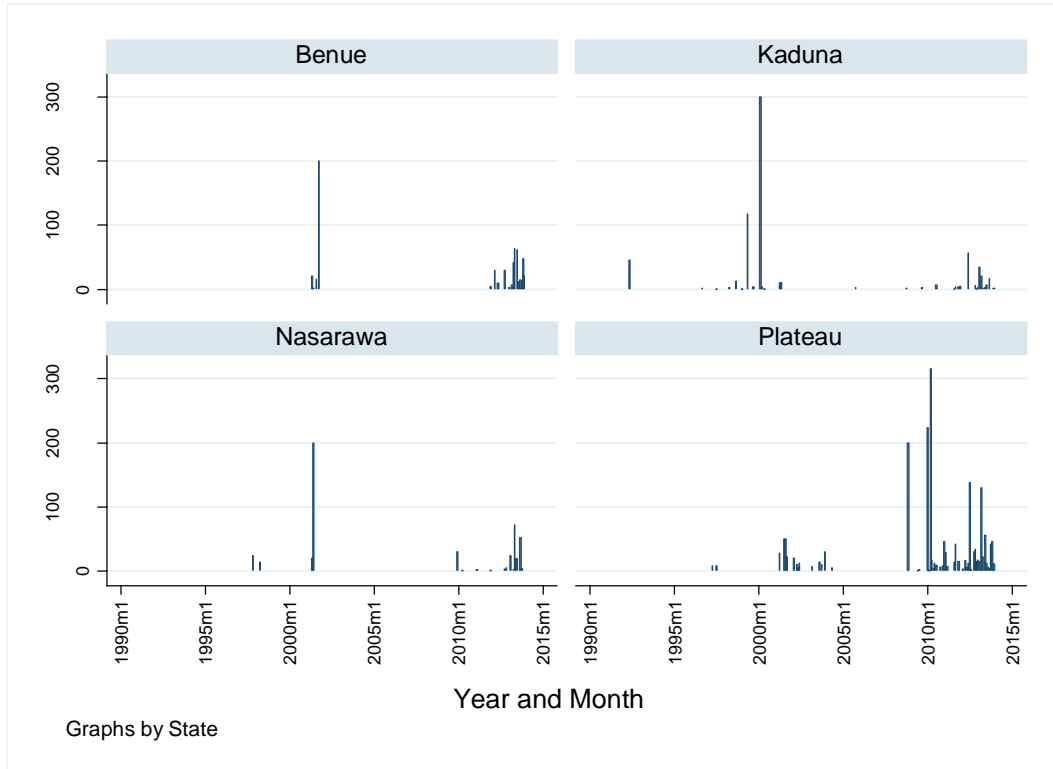


Figure 1. Farmer-pastoralist fatalities reported in each of the four study states by month, 1990-2013.

It is worth noting that our data management process has not eliminated violent events that may have been more influenced by religious tension at the national and state levels than strictly farmer-pastoralist conflict, many of which took place in urban areas.³ And yet whilst these instances of urban violence do not resemble the rural skirmishes over land that this study primarily targets, nor are they unrelated. Though the media termed the 2001 Jos riots “religious” clashes, underlying causes relate to economic and political factors linked to livelihoods and

³ For instance, following the return of democratic rule in 1999, a number of state governors in the north of Nigeria pushed through the adoption of Islamic Sharia law, including Kaduna in 2001. Riots representing non-Muslim minorities in those states became commonplace, and violence spread, too, to neighboring states where tensions ran high. Jos, for example, experienced riots in 2001 over the appointment of a Muslim politician to coordinate the federal poverty alleviation program within the state. Indeed, such urban riots over local political elections occurred in Yelwa (Plateau) in 2004, and again in Jos in 2008 and 2010 (see Figure 1, “Plateau”).

control of resources. Moreover, the causality between rural and urban violence may run in the other direction, as well. The January 2010 Jos riots seem to have precipitated a dawn raid by pastoralists on villagers in a nearby farming town, where the death toll may have exceeded 500 (citation).

Moreover, UCDP and ACLED have different time coverage periods (1990-2010 and 1997-2013 respectively). We have therefore modeled each dataset as a function of the other during the period of overlap (1997-2010), and used those models to predict the number of fatalities each source *would* have reported if it currently kept those records. We then averaged the two inferred datasets for each year by state to create a complete and, for our intents and purposes, authoritative dataset for the entire study period (1990-2013).

Choosing Predictors

The choice of predictor in the synthetic analysis has as triple criteria that the state (1) be geographically contiguous with one of the study states (i.e., share a border); (2) exhibit low rates of reported fatalities from any violent conflict event, per our national dataset, past the designated cut-off time; and (3) prove a statistically significant predictor of the outcomes (i.e., relevant to the model). The first criterion creates a cohort of potential predictors for each of the four study states, as shown in Table 1. However, if the number of statistically significant predictor states ultimately fell below two, we would begin the selection process again starting with all predictors listed in Table 1 pooled together (that is, all predictor states in Table 1 become eligible to predict any one study state regardless of whether they are geographically contiguous with the specific study state they are used to predict).

Table 1. Cohorts of contiguous predictor states grouped by study state. Study states and the FCT are greyed out.

Study State	Benue	Kaduna	Nasarawa	Plateau
Predictor Cohort	Cross River Ebonyi Enugu Kogi Nasarawa Taraba	Bauchi FCT Kano Katsina Nasarawa Niger Plateau Zamfara	Benue FCT Kaduna Kogi Nasarawa Taraba	Bauchi Kaduna Nasarawa Taraba

Exhibiting low rates of reported fatalities is established visually. Because all states reportedly experienced violent-conflict related fatalities in recent years, the predictors' levels of violence can only be established relative to those of the outcome states. Figure 2 illustrates all fatalities associated with violent-conflict events reported in each state in the study area and surrounding contiguous states by month. The four study states of Benue, Kaduna, Plateau, and Nasarawa, serve as the outcome to be predicted, and so are greyed out. The states of Kano and Taraba exhibit elevated violence levels in recent years, leaving the *relatively* peaceful states of Bauchi*,

Cross River, Ebonyi, Enugu*, Katsina, Kogi, Niger, and Zamfara* (where asterisks denote slightly elevated violence levels, making them less preferable as predictors). We also excluded the Federal Capital Territory (FCT), as it contains the Capital city of Abuja and might therefore be considered an idiosyncratic case for numerous associated reasons.

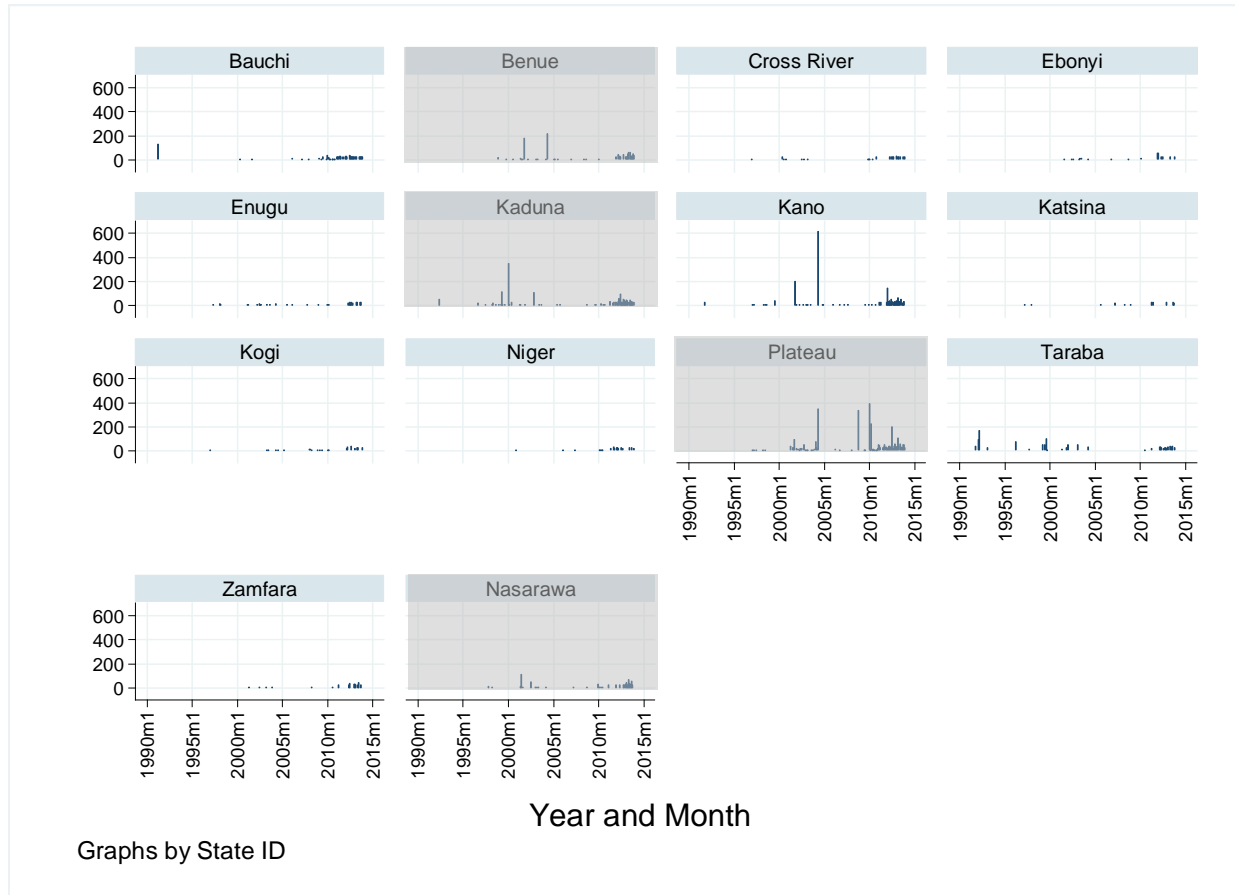


Figure 2. All fatalities reported by state and month in the predictor states. Study states (outcomes) are greyed out.

We then determined what temporal cut points we could use. In all cases, we chose the first month in which fatalities exceeded 25. This rule also tended to produce cut points coinciding with extended periods of heightened violence. We only run one synthetic control for each state. This is because the use of less violent states to predict alternative scenarios for more violent states is only defensible up to the point when the more violent states exhibit elevated violence levels. Once a state has a history of violence, it could be argued that the state’s economy, political climate, and/or social structure have been altered in a way that makes them more prone to future violence – the so-called “conflict trap” (Collier et al., 2003). With that in mind, Table 2 lists the chosen cut points for each study state.

Table 2. Cut-points in for synthetic modeling in each study state.

Study State	Date of First Extreme Violence	Fatalities Inferred
Benue	October 2001	182
Kaduna	May 1992	52
Nasarawa	June 2001	113
Plateau	April 2001	39* (riots)

* Denotes the beginning of a protracted period of violence.

Source: ACLED and UCDP, calculations by the authors.

Data Creation for IGR

We obtained data on Internally Generated Revenue (IGR) (and VAT, or Value Added Tax) from the annual reports of the Central Bank of Nigeria. Years of data availability since 1980 include the periods 1980-1984, 1987-2004, and 2007-2012. Once entered into spreadsheet form, we undertook three operations to make the dataset a more robust panel of comparable entries.

First, we created a number of historical reconstructions of present-day states, as Nigerian states have gradually been split up into smaller units. In most cases, those smaller units become states in their own right, whilst in some cases, the smaller units were combined with splinters of other states to make new states. Table 3 includes all Nigerian states whose boundaries have changed since 1980, along with descriptions of how they are related to the creation or break-up of other states. Some information is redundant, as entries for states sharing a common history will refer to one another.

Table 3. Nigerian states that have changed boundaries since 1980.

No.	State	Creation Status
1	Abia	Contained in Ibo state until 1992 Comprised half of Ebonyi state until 1996
2	Adamawa	Contained in former Gongola state until 1991
3	Akwa Ibom	Contained in former Cross River State until 1987
4	Anambra	Comprised present-day Enugu until 1991
5	Bauchi	Comprised Gombe until 1996
6	Bayelsa	Contained in Rivers State until 1996
7	Bendel	Former state comprising Delta and Edo states until 1991
8	Benue	Comprised half of present-day Kogi state until 1990
9	Borno	Comprised Yobe until 1991
10	Cross River	Comprised Akwa Ibom until 1987
11	Delta	Contained in former Bendel state until 1991
12	Ebonyi	Created from roughly equal-sized parts of Enugu and Abia states in 1996
13	Edo	Contained in former Bendel until 1991
14	Ekiti	Contained in Ondo until 1996
15	Enugu	Contained in Anambra until 1991
16	Gombe	Contained in Bauchi until 1996
17	Gongola	Former state comprising Adamawa and Taraba states until 1991
18	Imo	Comprised Abia state until 1991
19	Jigawa	Contained in Kano until 1991
20	Kaduna	Comprised Katsina until 1987
21	Kano	Comprised Jigawa until 1991
22	Katsina	Contained in Kaduna until 1987
23	Kebbi	Contained in Sokoto until 1991
24	Kogi	Created from roughly equal-sized parts of Kwara and Benue states in 1991
25	Kwara	Comprised half of Kogi state until 1991
26	Nasarawa	Contained in Plateau until 1996
27	Ondo	Comprised Ekiti state until 1996
28	Oyo	Comprised Osun until 1991
29	Plateau	Comprised Nasarawa until 1996
30	Rivers	Comprised Bayelsa state until 1996
31	Sokoto	Comprised Zamfara and Kebbi states until 1991
32	Taraba	Contained in Gongola until 1991
33	Yobe	Contained in Borno until 1991
34	Zamfara	Contained in Sokoto until 1996

In the case of states that have been split in two (call them i and j), the historical reconstruction of the original state h adds IGR from the later smaller units back into the totals reported for the state. In this way, $IGR_{h_t} = IGR_{i_t} + IGR_{j_t}$, where $t > t^*$, t represents the time in years, and t^* represents the time at which state h was split apart. For instance, Gongola, which was split in 1991 into Adamawa's and Taraba's, received a historical reconstruction that simply contains the sum of Adamawa's and Taraba's future respective IGRs for each year.

Using these historical reconstructions, we were able to impute hypothetical IGR to states in the hypothetical scenario that they had always retained their present-day boundaries. This was accomplished by first establishing a ratio of IGR from break-off state i to the historical reconstruction of the original state h in time $t^* + 1$ (or, if those data are unavailable, the next year for which data are available). Then that ratio is multiplied by the known historical IGR for

state h . Thus, historical IGR for future break-off state i would be calculated as $IGR_{i_t} = IGR_{h_t} \left(\frac{IGR_{i_{t^*+1}}}{IGR_{h_{t^*+1}}} \right)$.

The second operation we perform is a simple inflation adjustment, using the World Bank’s GDP deflator for Nigeria. This has the effect of putting all IGR data in 2010 constant Naira. Third, we perform an interpolation function. The interpolation allows us to fill in missing data cells, primarily from the periods 1985-1986 and 2005-2006, but also other randomly missing cells. For instance, in the aftermath of the 1996 state reorganization under the military Abacha regime, a number of newly formed states failed to report IGR – presumably because they still lacked the institutional capacity to collect it.

We compared the state IGR data derived in this way to the inferred state GDP growth percentages calculated by Obiliki (2014, p. 16) for the period 1999-2012. A cross-sectional regression yields a statistically significant relationship between the two, though the relationship is non-linear (see Figure 3).

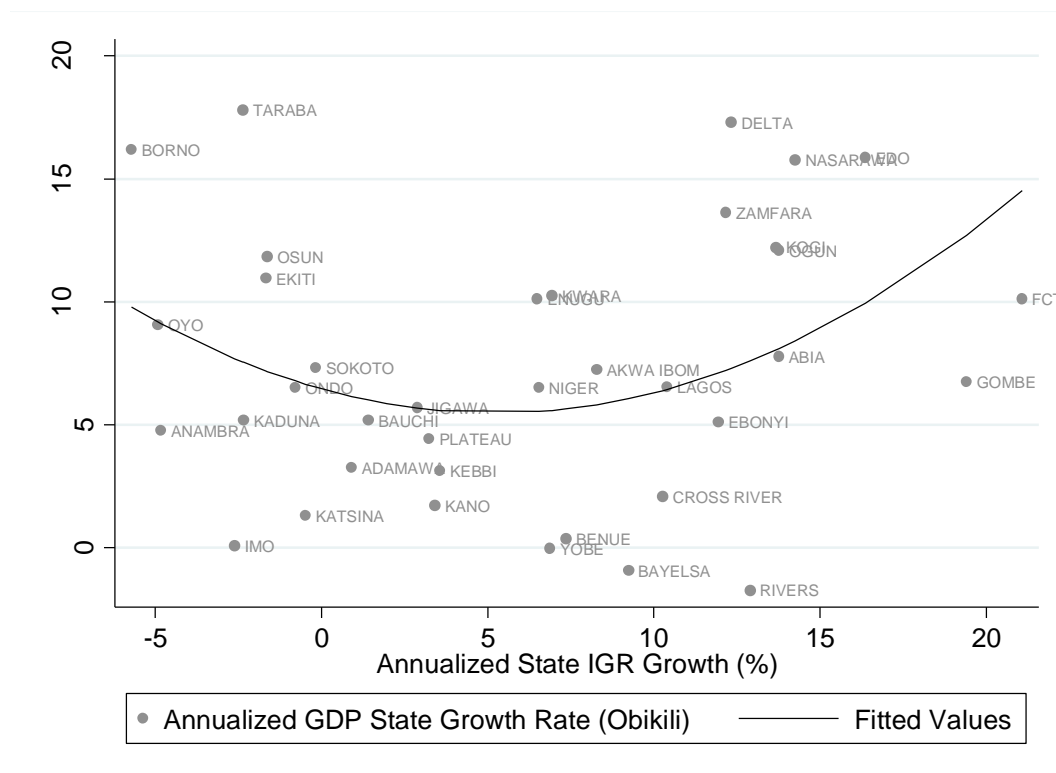


Figure 3. Annualized state GDP growth as a function of annualized state IGR growth, 1999-2012

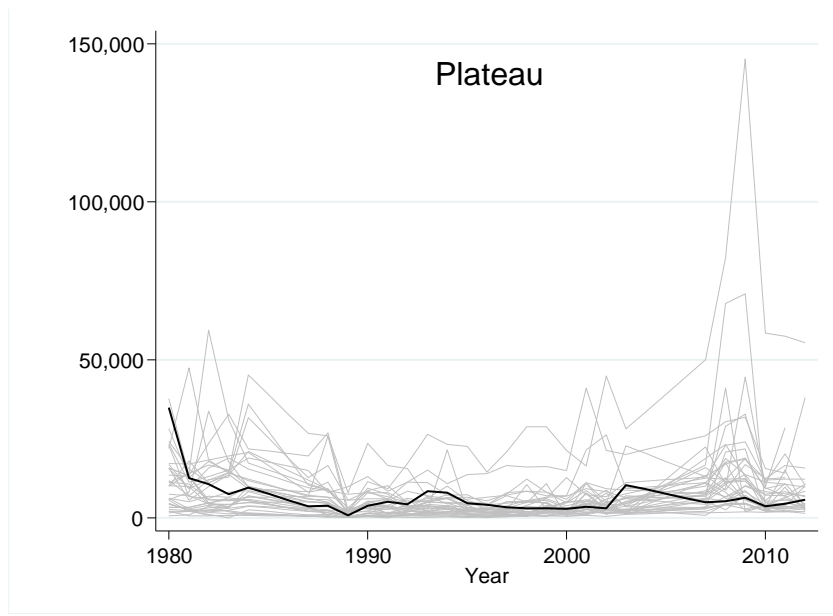
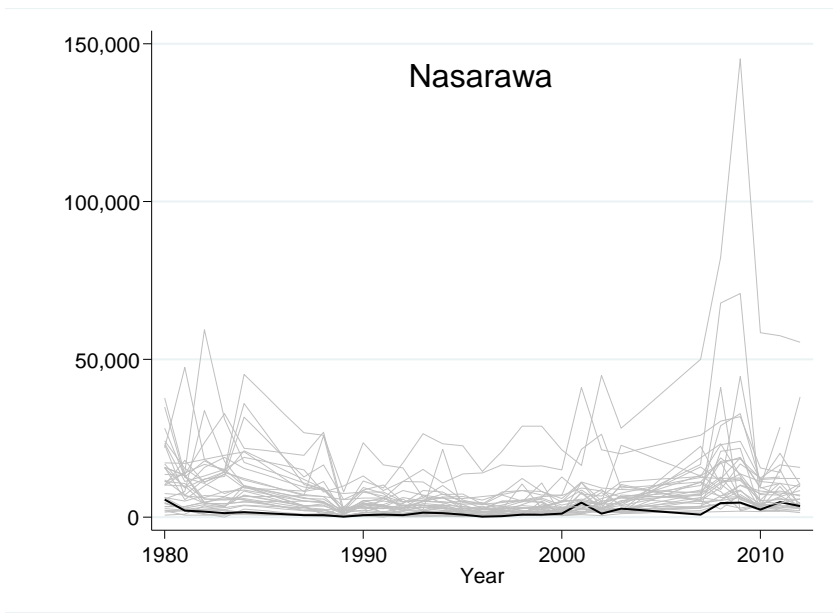
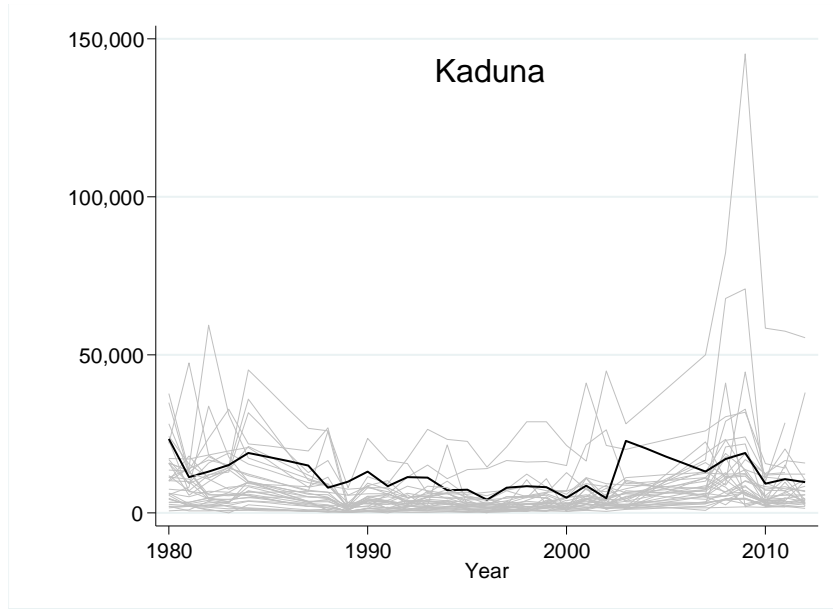
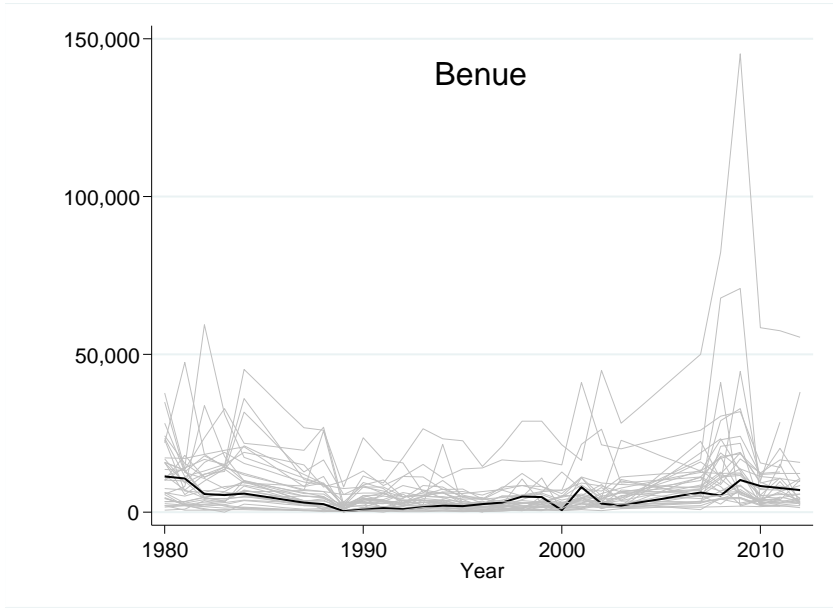


Figure 4. Imputed IGR trends for all Nigerian state with study states in bold black (Lagos excluded to preserve scale)

IGR and GDP do not necessarily grow in lockstep with one another, as IGR depends not only on GDP, but also on rates and modes of taxation, fiscal capacity, and the relative size of the black and grey markets, among other considerations. Figure 4, displaying imputed IGR trajectories for all Nigerian states except Lagos, illustrates this point. IGR declines to relatively low levels throughout the 1980s and 1990s, only rising again in the 2000s. This trough roughly corresponds to the reign of the Washington Consensus and a prevailing insistence on government retrenchment.

Empirical Specification

Once we have predicted IGR losses based on the synthetic control scenarios, we can regress them on farmer-pastoralist violent conflict event fatalities. However, at least two major criticisms can be leveled against these methods. The first is that the nature of the synthetic control generation means that there will be very little violence prior to the cut point, as well as very little derogation of the control from the actual IGR. This implies that losses will, by design, be at or near zero prior to the cut point. Taken together, these observations imply that our findings might be built into our methods from the start. The second criticism, as outlined above, is that of endogeneity, since IGR losses presumably influence violence, in addition to being influenced by them. Relatedly, the cut points, while defined by surges in violence, may occur synchronously with variations in unobserved variables. In that case, the predicted losses in IGR may not be entirely accounted for by violence alone.

Therefore, we propose two modifications to a simple, uncontrolled OLS regression. The first modification is the introduction of two simple control variables for (a) whether or not the cut point for that state has been reached or not, and (b) how many years since the cut point was reached (since the predictions will tend to degrade and become more volatile the farther they are from the cut point).

The second modification we propose is the use of an IV regression, pending the outcome of a Durbin-Wu-Hausman test for endogeneity. For an instrumental variable, we have chosen to use the phenomenon of adoption of Sharia law by certain states in northern Nigeria. Beginning with the restoration of democratic rule in 1999, state governments of various northern Nigerian states began introducing bills to adopt Sharia law, whether in restricted form (i.e., dealing only with interpersonal matters) or expansive form (i.e., dealing with all criminal matters). Such proposals were highly contentious, and may have catalyzed some episodes of violence in northern Nigeria in the run-up to their adoption. Our idea was that the anxiety around Sharia adoption in *neighboring* states would cause violence, and yet such anxiety was not likely to affect IGR in one's home state, except through the mechanism of violence. (In contrast, the imposition of Sharia law in the same state may or may not both cause violence and affect IGR, thus suffering from the same endogeneity problem.) We started by defining a dummy variable for Sharia law anxiety, $S_{jt} \in (0,1)$, that takes on a value of 1 when state j , which is contiguous to state i , adopts a form of Sharia law in time t . We then define $S_{jt} \in (0,1)$ if any $S_{jt} = 1$ – that is, if any

neighboring state adopts Sharia in that year. Finally, we create our instrumental variable as the inverse of post-1998 years until S_{jt} . In other words, we consider the possibility for anxiety to be minimal until the restoration of democracy in 1999, but that anxiety then builds in the run-up to other states' Sharia proposals. The instrumental variable for state i in year t is then defined as:

$$IV_{it} = \begin{cases} \frac{1}{1+|t_{S_{jt}}-t|}, & t_{S_{jt}} \geq t \geq 1999 \\ 0, & t_{S_{jt}} < t \mid t_{S_{it}} < t \\ 0, & t < 1999 \end{cases}$$

where $t_{S_{it}}$ denotes the time at which state i adopts Sharia law.

Finally, we estimate a population attributable fraction to determine the share of IGR losses attributable to farmer-pastoralist conflict. PAF is usually used to determine the proportion of disease incidence that is attributable to exposure to the risk factor (Greenland & Drescher, 1993; Last, 2001, p. 137). Here we want to attribute the proportion of the wealth destruction that is attributable to exposure to violence. The PAF for adjusted predictions is often defined:

$$PAF = \frac{\Pr(E|D) * (RR_{adjusted} - 1)}{RR_{adjusted}}$$

where $\Pr(E|D)$ represents the prevalence of exposure given the disease (in our case, fatalities), and $RR_{adjusted}$ represents the adjusted relative risk of disease (here, the adjusted prediction of IGR losses as a function of violence) (see, e.g., Doidge, Segal, & Gospodarevskaya, 2012).

Results

The synthetic control analysis produced predicted trends and confidence intervals for each study state. Actual IGR and these synthetic control predictions are illustrated in Figure 5. It is clear that the actual IGR for all states generally falls below the synthetic control, as would be expected – though it does not always fall outside of the 95% confidence interval. The summed difference between the actual IGR and synthetic control represents a hypothetical financial loss to the state government. Summing those losses and dividing them by the total summed IGR in the synthetic control yields a percentage of total government revenues lost during the period from the cut point for each state to 2012. These absolute and percentage-wise losses (presented in Table 4) vary by state and whether or not the most conservative assumptions are underpinning the estimates. Plateau state is predicted to have lost a greater share of its hypothetical IGR than the other states – fitting with the fact that Plateau has experienced a greater amount of violence than the other states in recent years. Kaduna, host of the longest-running farmer-pastoralist conflict, we estimate to have suffered IGR losses ranging from NGN 103m-NGN 238m (\$677k-\$1.56m). Figures in Table 4 represent total losses in comparison to a hypothetical alternative past; the share of total losses attributable to farmer-pastoralist violent conflict are estimated using the PAF analysis and presented in Table 8, below.

Table 4. Absolute and percentage-wise IGR losses from the cut point to 2012.

State	Cut Point	Total IGR	Predicted Effect (Avg. Estimate)	Predicted Effect (Conservative)
Benue	2001-02	61,839	-55,714 -47%	0 0%
Kaduna	1991-92	238,791	-70,127 -24%	-35,886 -14%
Nasarawa	2000-01	34,366	-31,782 -48%	-8,592 -20%
Plateau	2000-01	70,109	-215,126 -75%	-81,236 -54%
Total	NA	393,761	-372,749 -49%	-125,714 -24%

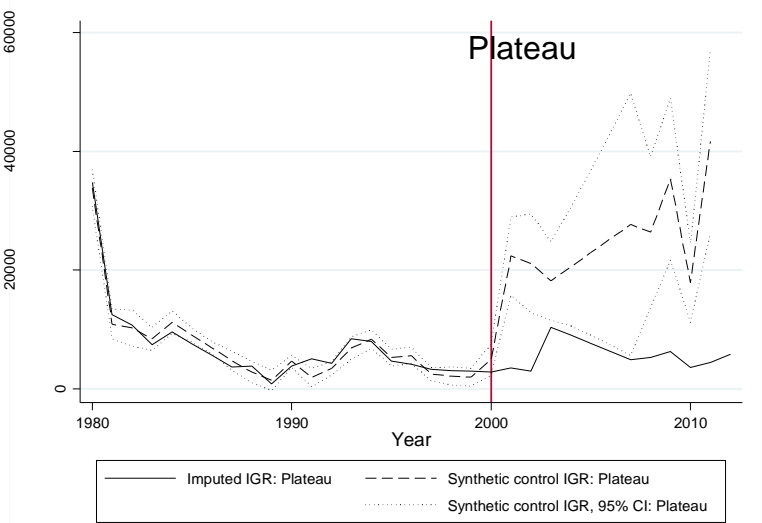
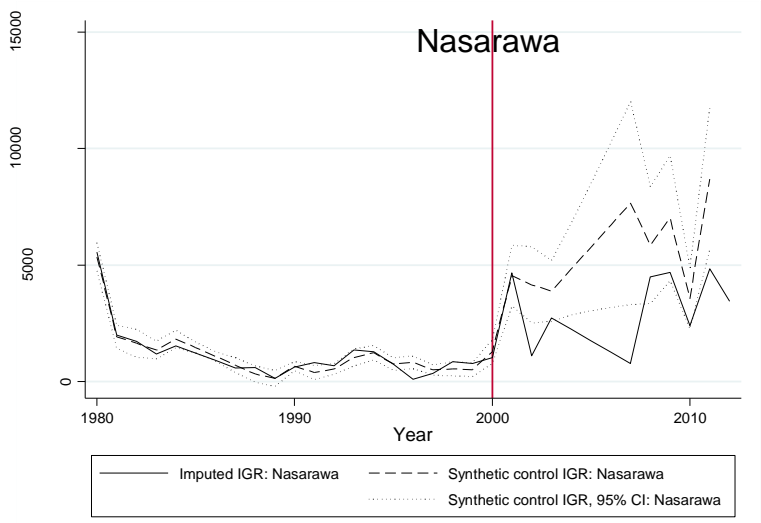
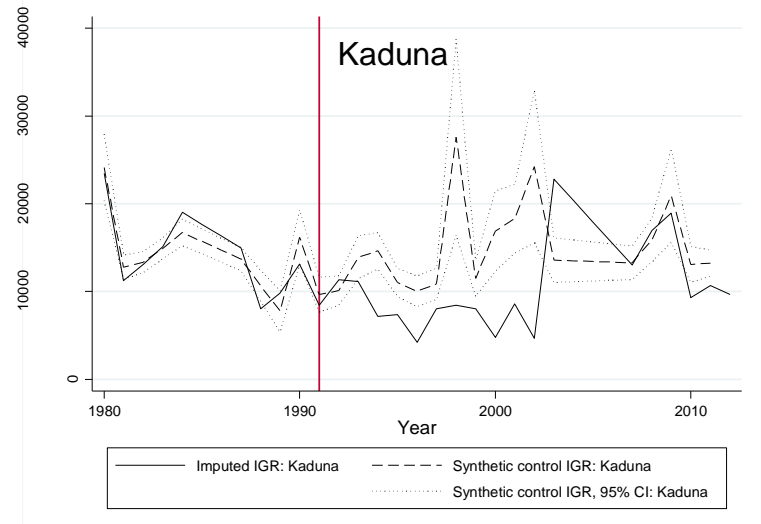
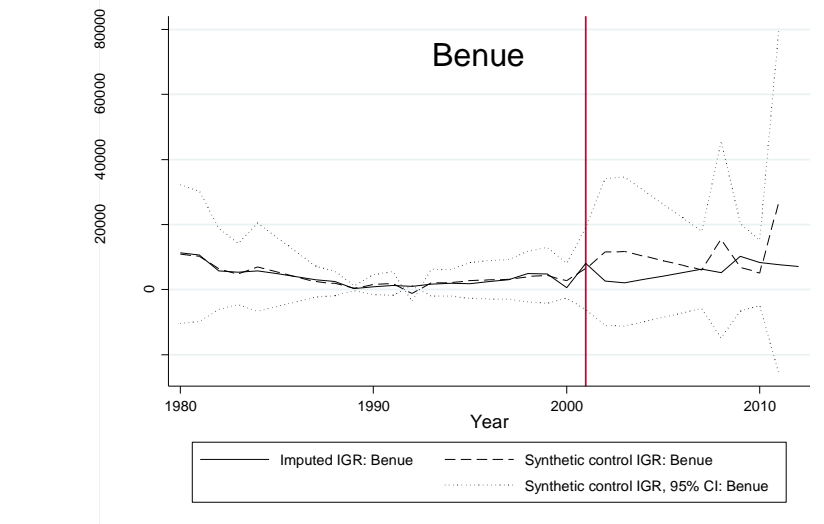


Figure 5. Actual and predicted IGR for Benue, Kaduna, Nasarawa, and Plateau states with cut-points in red, 1980-2012

Figure 6 illustrates time trends for fatalities and IGR losses in the four study states. It is important to note that, whilst the synthetic controls and thus predicted IGR losses are predicated on cut points defined by violent events, violence data in no way parameterizes or otherwise influences the synthetic control creation. That is, violence data does not enter the predictive models as a control variable. Rather, its only influence is felt negatively and indirectly in the fact that the predictor states are not (or, rather, less) violent. This being the case, it is interesting to note that the predicted IGR losses seem to occur during or just following a particularly violent year, particularly in in Benue and Plateau.

We therefore attempt to test this relationship more rigorously. Table 5 shows time-series OLS estimates with fixed-effects at the state level of IGR losses (both average and conservative estimates) on farmer-pastoralist violence and lagged farmer-pastoralist violence variables for each state⁴. Both concurrent and lagged violence variables manifest a strong, positive statistical relationship to the outcome of IGR losses. (Note that this is the same as saying there is a strong, negative relationship to the outcome of difference between the actual imputed IGR for each state and its corresponding synthetic control.)

Table 5. Fixed-effects OLS regression results of estimated IGR losses (average and conservative estimates) on fatalities and lagged fatalities by state.

VARIABLES	(1) IGR Losses (Avg.)	(2) IGR Losses (Avg.)	(3) IGR Losses (Conservative)	(4) IGR Losses (Conservative)
ACLED / UCDP fatalities	8.366* (4.694)		6.032** (2.624)	
Lagged Estimated Fatalities		21.05*** (4.214)		11.82*** (2.414)
Constant	5,327*** (829.0)	4,938*** (758.8)	1,792*** (466.0)	1,589*** (437.4)
Observations	93	89	92	88
R-squared	0.035	0.229	0.057	0.224
Number of stateid	4	4	4	4
Log likelihood	-961.0	-909.9	-897.1	-850.7

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

⁴ “Lagged violence” means that we are testing the statistical relationship not between violence and IGR losses in the same year, but violence in a previous year and IGR losses in a current year. This model then tests the idea that violence acts upon the economy in ways that take time to be registered in IGR.

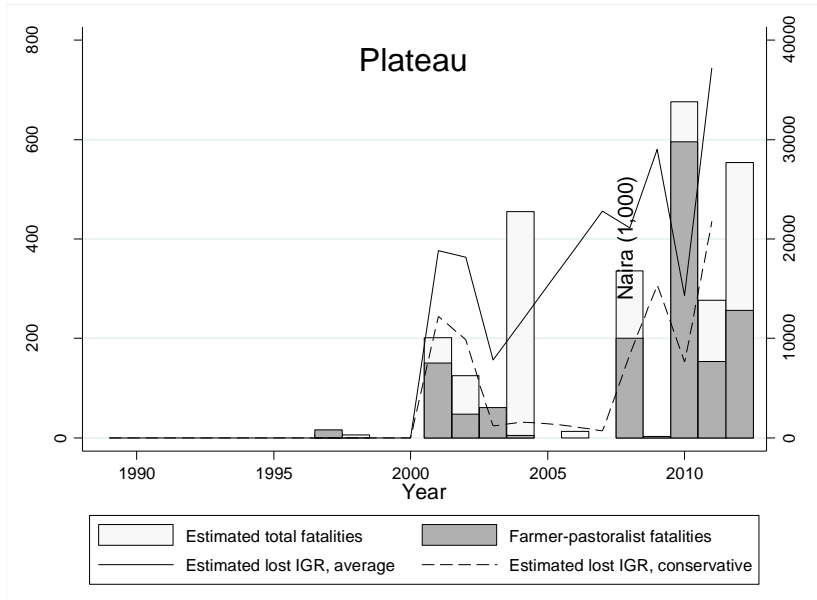
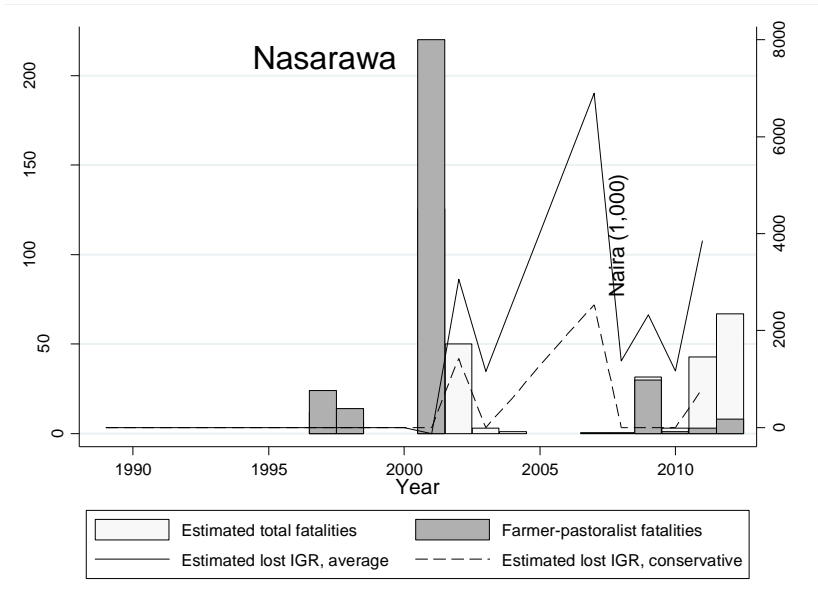
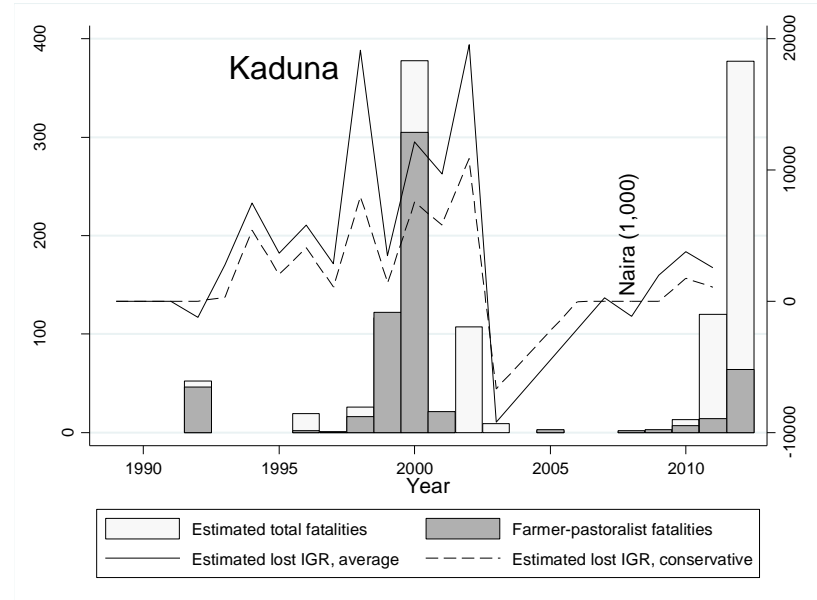
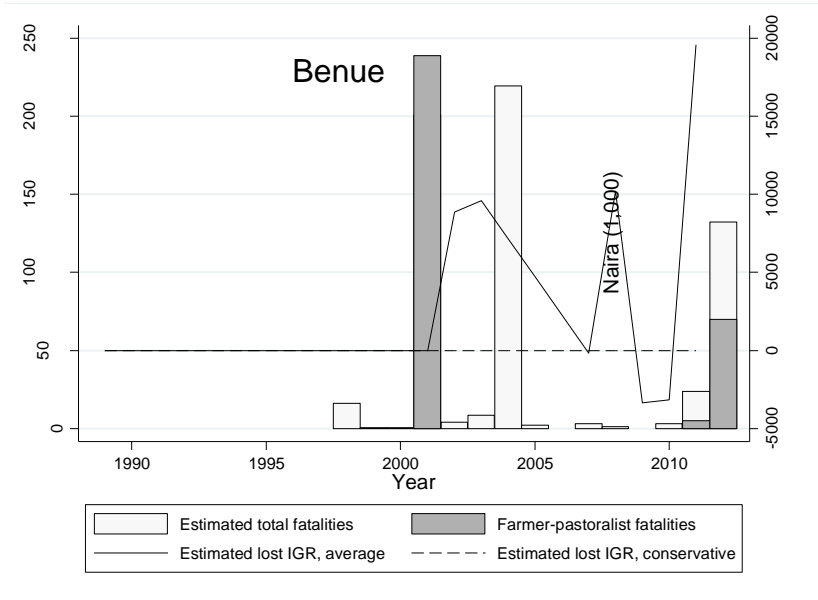


Figure 6. Estimated fatalities and synthetically predicted IGR losses in each study state by year, 1990-2012

Table 6 displays the results of time-series OLS regressions with the inclusion of cut point controls. Of note, the effect sizes of fatalities, whether lagged or not, have dropped to varying extents.

Table 6. Fixed-effects OLS regression results of estimated IGR losses (average and conservative estimates) on fatalities and lagged fatalities by state, controlling for cut point.

VARIABLES	(1) IGR Losses (Avg.)	(2) IGR Losses (Avg.)	(3) IGR Losses (Conservative)	(4) IGR Losses (Conservative)
Estimated Fatalities	13.18 (8.160)		13.65*** (4.446)	
Lagged Estimated Fatalities		36.46*** (7.544)		26.05*** (3.912)
Cut Point	8,818*** (1,865)	7,748*** (1,731)	2,429** (1,016)	1,760* (897.6)
Years Since Cut Point	-105.0 (190.6)	-89.12 (174.0)	-43.94 (103.8)	-39.66 (90.23)
Constant	-819.1 (1,020)	-834.1 (985.1)	-161.2 (555.9)	-65.11 (510.7)
Observations	91	87	91	87
R-squared	0.334	0.465	0.207	0.430
Number of stateid	4	4	4	4
Log likelihood	-918.3	-869.3	-863.1	-812.2

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

We use IVs similar to those described in McDougal (2015) concerning the adoption of Sharia law. In this case, we employed one time-decayed variable denoting the adoption (or not) of a Sharia law in civil (1) or all (2) legal matters, divided by the years since adoption plus one. We also employed a similarly-constructed variable for the adoption of Sharia law in *neighboring* states. We reasoned that the issue of Shari'a law adoption may prove a catalyst for violence, but likely doesn't greatly affect the macroeconomy or IGR collection. Both of these proved exogenous to the outcome and relevant to the predictor (farmer-pastoralist fatalities). We conducted Durbin-Wu-Hausman tests with endogenous predictors IV_{it} democracy, cut point, years since cut point, adoption of Sharia law, Sharia law adoption time decay for the state and its neighbors, and non-farmer-pastoralist fatalities. The test revealed that IGR losses are endogenous to fatalities if conservative IGR losses are use and/or if lagged fatalities are used. We ran fixed-effects IV regressions on all models, including the exogenous predictor of Sharia law imposition. (The latter term is uncorrelated to both IGR and violence on its own.) The results are displayed in Table 7, and the greyed-out columns represent IV regressions that the Durbin-Wu-Hausman

test indicated were unnecessary. The relationship between lagged violence and IGR losses is of a larger magnitude than that between un-lagged violence and IGR losses, though all models show a positive and significant relationship. The average loss estimates suggest that for every fatality classified as being attributable to farmer-pastoralist conflict, the local state government stands to lose NGN 162,000 in 2010 Naira (roughly \$1,065 in 2010 USD) the following year. Conservatively, each farmer-pastoralist conflict fatality costs the local state NGN 48,730 in 2010 Naira (roughly \$320 in 2010 USD).

Table 7. Fixed-effects IV regression results of estimated IGR losses (average and conservative estimates) on fatalities and lagged fatalities by state. Columns indicated as non-endogenous are greyed out.

VARIABLES	(1) IGR Losses (Avg.)	(2) IGR Losses (Avg.)	(3) IGR Losses (Conservative)	(4) IGR Losses (Conservative)
Farmer-Pastoralist Fatalities	63.83*** (20.75)		32.42*** (9.713)	
Lagged Farmer-Pastoralist Fatalities		162.0*** (52.24)		48.73*** (15.29)
Constant	88 4	87 4	88 4	87 4
Observations	63.83***		32.42***	
Number of stateid	(20.75)		(9.713)	
Log likelihood

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Population Attributable Fractions

The models presented above in Table 7 then account for both the cut point and the endogeneity problem, and represent our best attempts to distinguish IGR losses stemming from farmer-pastoralist violence as estimated in the synthetic control models. We now wish to examine what fraction of those losses is directly attributable to such violence by employing a PAF calculation. The results of these calculations made by employing Stata's PUNAF module are presented in Table 8. We calculate that between 69% (Benue) and 91% (Plateau) of IGR losses predicted by the synthetic control calculations can be attributed to farmer-pastoralist violence.

Table 8. Population Attributable Fraction (PAF) calculations for IGR losses in the four study states. All figures in 2010 Nigerian Naira unless except percentages; 95% confidence intervals in parentheses.

		Benue	Kaduna	Nasarawa	Plateau
Mid-Range	Status Quo	2,154 (594.4, 7804.9)	4,199 (2356.6, 7481)	2,438 (808.9, 7350)	8,250 (5406.6, 12588.7)
	Violence @ Zero	310 (0, 24300000)	310 (0, 24300000)	310 (0, 24300000)	310 (0, 24300000)
	PAF (Loss Reduction Fraction)	86%	93%	87%	96%
	Savings (1,000 2010 Naira)	1,844	3,889	2,129	7,940
Conservative	Status Quo	804 (293.2, 2206.1)	1,419 (860.7, 2340.1)	890 (367.3, 2155.7)	2,637 (1791.3, 3883.2)
	Violence @ Zero	250 (4.2, 14923.3)	250 (4.2, 14923.3)	250 (4.2, 14923.3)	250 (4.2, 14923.3)
	PAF (Loss Reduction Fraction)	69%	82%	72%	91%
	Savings (1,000 2010 Naira)	555	1,169	640	2,388

Table 9 is a recreation of Table 4, modified by the PAFs calculated above. The last row gives the total endogeneity-adjusted IGR losses as a percentage of the figures presented in Table 4. Calculations of IGR losses taking endogeneity into account are roughly 65-75% the size of those predicted without such adjustments.

Table 9. Absolute and percentage-wise IGR losses from the cut point to 2012, modified to take endogeneity into account.

State	Cut Point	Total IGR	Predicted Effect (Avg. Estimate)	Predicted Effect (Conservative)
Benue	2001-02	61,839	-47,704 -44%	0 0%
Kaduna	1992-93	227,448	-64,955 -22%	-29,570 -12%
Nasarawa	2000-01	34,366	-27,746 -45%	-6,180 -15%
Plateau	2000-01	70,109	-207,051 -75%	-73,543 -51%
Total		393,761.21	-347,456 -47%	-109,294 -22%
As Percentage of Synthetic Predictions			96%	90%

Discussion

We have estimated a net loss to state governments' IGR ranging from 0-44% of potential revenues in the case of Benue over the 2001-2012 period to 51-75% in the case of Plateau over that same period. In total, the four study states of Benue, Kaduna, Nasarawa, and Plateau are estimated to have lost between NGN 109 million and NGN 347 million in IGR due to the conflict – roughly \$719 to \$2.3 million in 2010 USD, or 22-47% of their potential IGR collection. Finally, we have argued that these synthetic control scenarios are reliable by demonstrating that they respond as we would hypothesize to the farmer-pastoralist violence – losses mount in response to killings.

We have also demonstrated that it is possible to reconstruct a hypothetical alternative history of internally generated revenue (IGR) collection at the state level in Nigeria over the period 1980-2012 – one in which conflict-affected states are assumed not to have suffered from violence. We have also demonstrated a method for dealing with the typical problems of violence-economy endogeneity attributed to such synthetic control models in cost of conflict analyses.

It bears noting that these estimates of impact on IGR generally exceed those estimated by other economic studies of the cost of conflict on GDP. On average, countries at war have been

estimated to grow between 2.2 and 6 percent slower than during peace (Skaperdas et al., 2009, p. 8). Some countries experience far worse effects, as in the case of Afghanistan where per capita GDP fell at 7.5 percent annually from 1990 to 1995 (Ibid.). The figures we have calculated for total losses per state accrued over time – 11 years for Benue, 20 for Kaduna, 12 for both Nasarawa and Plateau. If we back calculate the cost of conflict as a percentage IGR reduction, we obtain (assuming a reasonable 5 percent IGR growth rate, given Nigeria's GDP growth rate) 0 - 10.6 percent for Benue, 1.2 – 2.3 percent for Kaduna, 2.6 – 10.0 percent for Nasarawa, and 12.1 – 26.6 percent for Plateau.

It is important to note, however, that IGR and GDP are not at all synonymous. There are a number of reasons to think that the effect of violence on IGR might be more pronounced than on GDP. For one, while conflict-affected communities may still engage in some form of production, it may be less taxable – whether because their livelihood has slipped into the grey or black market, or because they come to rely more on social reciprocity and barter exchange than the money economy. For another, the fiscal capacity of the state to assess and collect taxes may be reduced in conflict-affected areas, whether because it is deemed dangerous to venture there, or because communities (especially pastoralist communities) are on the move.

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