Subnational border reforms and economic development in Africa

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Abstract

This paper is the first that comprehensively identifies all territories in Africa affected by subnational border reforms during 1992-2013 with GIS methods. With this data, we study the effect of subnational border reforms on local economic development. Difference-in-difference regressions at the grid-level with nighttime luminosity as proxy for local economic activity suggest that border changes have, on average, positive long-run economic effects. However, we also observe significant country-level heterogeneity, which suggests that prevailing institutions as well as fundamental country-specific characteristics are vital determinants of the economic efficacy of subnational border changes. The (official) reasons given for subnational border changes are less important.

Keywords: Border reforms, economic development, night-light data, Africa

JEL codes: D73, H77, R11

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1 Introduction

Several countries in Africa have recently reformed the shape and structure of their primary subnational units – typically labeled states, regions, or provinces. In particular, the borders of many subnational units have been redrawn (Grossman et al., 2017; Fox and Gurley, 2006). Primary subnational units in Africa are important administrative centers with an independent political life and their territorial organization is often a source of controversy and conflict (Elaigwu, 2008). It can thus be expected that their boundaries will continue to be adjusted in the future. Yet, evidence on how the redrawing of subnational borders affects local economic development is scarce. This is an important gap in our understanding of public sector reforms in Africa. Are subnational border reforms a promising policy to accelerate economic development? Does it matter why borders of subnational units are changed? Were border reforms in some countries more effective in promoting local development than in others?

Subnational border reforms are often part of broader public sector reforms intended to, at least nominally, increase administrative efficiency (Erk, 2014) or to pacify ethno-regional conflicts (Fessha, 2012). In turn, border reforms might indeed promote economic activity. On the other hand, rather than with benign intentions, politicians might implement subnational border reforms for parochial reasons, for example to advance political or electoral goals. In this were the case, border reforms might exacerbate administrative inefficiency, patronage, and conflicts (Grossman and Lewis, 2014; Hassan, 2013; Abramson et al., 2022).

We study empirically the local economic consequences of subnational border reforms in Africa over the period 1992-2013 in order to understand whether and under which circumstances subnational territorial reforms can promote (local) economic development. To identify subnational border changes across the entire continent of Africa, we make use of shapefiles on administrative borders from the United Nation's Global Administrative Unit Layers (GAUL) project. These shapefiles are available for every year during the sample period and show the borders of all primary subnational governments (henceforth referred to as regions) across the globe in a given year. Consequently, any changes to subnational borders from one to the next

year imply border reforms. We first identify algorithmically these changes with geographic information system (GIS) software and then validate by hand the list of border changes identified by our GIS-based method using the comprehensive data on subnational units and their history provided on the updated online supplement[1] to Law (1999).

A challenge for our subsequent empirical analysis is to determine the main geographical unit of analysis. The subnational regions delineated by the GAUL maps cannot be easily used as units of analysis as regions affected by a border change by definition cease to exist in their current form.[2] Hence, we cannot construct a consistent time series at the level of subnational regions. We address this by dividing Africa into a grid of 0.5 $\times$ 0.5 degree cells (an area of about 55km^2 at the equator). We use these cells as time-constant units in our estimations. Specifically, we project the changes to the line features identified from the GAUL shapefiles onto this grid of cells to determine whether a particular cell (i e., the territory it is overlayed on) was affected by a border change (i. e., the emergence of a new or the disappearance of an existing border line).

Another challenge is how to measure economic development at the subnational level. GDP calculations for developing and/or autocratic countries are questionable due to poor statistical capacity or even outright manipulation (Jerven, 2013; Martínez, 2022). Moreover, even if existing GDP data were reliable, it is typically not available at lower levels of geography, notably at the grid-level. We thus follow recent research and use nighttime luminosity as measured by orbital satellites as proxy for economic development (Henderson et al., 2012). Specifically, we calculate night light output in all 0.5 $\times$ 0.5 degree cells for each year between 1992 to 2013 and match this data to the grid-level data on subnational border changes.

Interpreting the redrawing of subnational borders as policy treatments, we implement a difference-in-differences design at the cell level. Specifically, we explore whether cells that were affected by a border change witness an improvement or deterioration in economic activity, as proxied by cell-level luminosity. Our results imply that border changes on average

[1] See `www.statoids.com`

[2] That is, if a existing region A is split into two new regions called B and C, the region A ceases to exist.

increase luminosity in the post-treatment period by about 25%. Using the estimate for the elasticity between night lights and GDP of 0.3 by Henderson et al. (2012), we calculate that cell-level GDP increases in the long-run by 7.5% because of a border change. Differentiating between border changes that lead to the emergence of a new border line within a cell (splits) and those that involve the disappearance of border lines (mergers), we observe that, while both forms of border changes have a significantly positive effect on local development, mergers are on average more beneficial to growth than splits.

One inherent limitation of our setting is that border changes are not random events. Accordingly, one concern is that cells affected by a border change were on a different economic trajectory than other, unaffected cells. If border changes are endogenous to economic developments, our estimates may be confounded. On the other hand, administrative and political concerns often appear to be the main motivation for border changes. More specifically, prior evidence suggests that the creation of new subnational units in African countries follows an electoral cycle, especially in areas with strong political opposition (Grossman and Lewis, 2014; Hassan, 2013). We have also hand-collected information on the official reasons given for a large share of the border changes in our sample. The primary official reason given for border changes is an attempt to increase "administrative efficiency", often in the context of broader decentralization or public sector reforms. There is little indication that border changes are implemented in response to (negative or positive) local economic shocks. Hence, to the extent that border changes are orthogonal to economic developments, our empirical approach should produce unbiased estimates. Finally, note that our unit of analysis are relatively small cells that are affected by the emergence or vanishing of a border line, rather than the subnational regions themselves. It is unlikely that economic developments specifically in a border cell will induce territorial readjustments that have consequences for the entire subnational region.

Nevertheless, it is of course possible that some border changes in our sample were implemented for economic reasons. We address this possibility as follows.[3] First, we control for

[3]It is not feasible to address such endogeneity concerns in our cross-country context by means of a quasi-experiment as there is no institutional mechanism that would induce quasi-random variation in subnational border

country-specific year dummies to account for country-wide economic developments. Second, we verify the common trend assumption with event-study plots. We observe no strong pre-trends in night lights shortly before border changes, reaffirming that border changes were not primarily driven by differences in economic trajectories. Third, making use of our hand-collected data on the reasons for border changes, we report separate estimates for border changes that were, at least nominally, implemented for non-economic reasons.

To narrow down the mechanisms through which subnational border changes might affect local economic development, we conduct various heterogeneity analyses. We find that border changes are particularly effective when implemented by authoritarian governments with relatively strong state capacity and in contexts with significant political violence and instability. This indicates that border changes can be a suitable tool for less democratic countries to address political instability – e. g., due to underlying ethnic conflicts – if they have sufficient state capacity. We also find that border changes are particularly effective in countries that are more populous and have a large land area. That large and populous countries benefit more from border changes is consistent with the observation that the number of subnational administrative units has increased over the last few decades in Africa (Grossman and Lewis, 2014). Subnational administrative units were possibly too large historically and thus not sufficiently capable to accommodate local heterogeneity, particularly in bigger countries. We also observe that border changes are more effective in poorer countries, possibly because the growth potential through public sector reforms is larger in this set of countries.

On the other hand, linking the (official) reason for subnational border changes to subsequent local economic performance, we find no significant heterogeneity along the official reasons given for a border change. Border changes that were implemented as part of a decentralization reform or other major state reforms are as effective as border changes implemented for other reasons. This may indicate that fundamental country-specific features rather than the stated

changes across all of Africa. While the cross-country nature of our data poses a challenge for the internal validity of our estimates, it increases their external validity. Overall, we believe that this is – in this particular case – a useful tradeoff.

motivations determine whether or not a border change will promote subnational economic development.

Motivated by the apparent importance of country-specific characteristics for the economic efficacy of subnational border changes, we also estimate country-specific treatment effects. We find that there is indeed significant heterogeneity in how subnational border changes affect local development across countries. Ethiopia, Sudan, and Tanzania exhibit large positive effects. Border changes in other countries had no or even negative effects. Since Ethiopia, Sudan, and Tanzania are relatively large and have implemented several border changes, they contribute a large number of cells to the estimation of the average treatment effect, ostensibly causing it to turn positive.

This paper contributes to various strands of literature. First, our results are related to the still inconclusive literature on subnational border changes in the developing world and their implications for economic outcomes (see Pierskalla (2019) for a review). On the one hand, various studies find that administrative splits can have positive local effects. For example, Asher and Novosad (2015) show that in India, living conditions in new states that were carved out of existing states improve after splits. Swee (2015) shows that the partitions of municipalities after the Bosnian War led to better educational outcomes. Dahis and Szerman (2020) document similar improvements in educational attainment after municipal splits in Brazil. Grossman et al. (2017) find that an increase in the number of regional administrations per country improves aggregate health outcomes.

On the other hand, several contributions suggest that administrative splits might cause harmful externalities and a race to the bottom through intensified inter-jurisdictional competition. For example, Burgess et al. (2012) show that a higher number of government units in Indonesia exacerbates deforestation. Similarly, Lipscomb and Mobarak (2017) find evidence for negative spillovers in water pollution after splits of counties in Brazil. Bazzi and Gudgeon (2021) show that while splits can decrease conflicts, they may also increase violence if they lead to more ethnic polarization. Similarly, Alesina et al. (2019) argue that more polarized jurisdictions due to government redistricting experience deteriorating levels of public services.

We contribute to this literature by linking border changes to local economic development. While there are, as reviewed above, prior studies that explore how border changes affect economic outcomes in individual countries, we are the first to study their economic consequences at the subnational level for the entire African continent. Thus, our findings contribute to the attempt to "condense and synthesize the current state of knowledge about the effects of government unit proliferation" (Pierskalla, 2019, p. 133).

We are also the first to specifically study the economic consequences of adjustments to border lines, irrespective of whether these adjustments were due to splits, mergers and other variants of border reforms. Most of the previous literature has focused primarily on splits of a limited number of administrative units, arguably because splits have been the most common form of border change in the developing world (e.g. Bazzi and Gudgeon (2021) and Grossman et al. (2017)). Finally, we illuminate mechanisms thorough which border changes may cause local development by showing under which conditions and in which countries border changes are particularly effective in promoting local development.[4]

This paper also contributes to the literature on the optimal size of political jurisdictions. On the one hand, costs associated with preferences heterogeneity across the population likely increase with the size of a region (Oates, 1999). On the other hand, larger regional units can result in cheaper provision of public goods due to scale economies (Bolton and Roland, 1997; Alesina and Spolaore, 1997). Another drawback of smaller (and thus more) regional units is, as alluded above, that this would imply stronger inter-jurisdictional competition, which may lead to a race to the bottom (Zodrow and Mieszkowski, 1986). Even though we focus on economic development rather than welfare, our results, which indicate that both splits and mergers can

[4]By considering mergers, this paper is also related to the literature on the economic consequences of amalgamations of administrative units (Reingewertz and Serritzlew, 2019). The existing literature on this question, however, focuses on local governments in industrialized countries. For example, Egger et al. (2022) show that municipal mergers have a positive net effect for economic activity in Germany. Pickering et al. (2020) find similar evidence for Japan. Blesse and Baskaran (2016) find that (voluntary) municipal mergers do not reduce local government expenditures. Reingewertz (2012) and Blom-Hansen et al. (2014), on the other hand, show that mergers significantly reduce local spending in Israel and Denmark, respectively.

contribute to economic development, are consistent with the notion that the preference costs associated with larger regions must be weighed against their potential economic benefits on a case by case basis.

2 Background

2.1 Subnational borders in Africa

Many developing countries have artificial administrative borders inherited from colonial times. Artificial borders are particularly prevalent in African countries (see Easterly and Levine (1997) for early evidence on the topic). Since the "scramble for Africa" in the late 19th century, African borders often follow latitudes and longitudes lines rather than natural borders (e.g. rivers) and do not coincide with the historical territories of the local ethnic groups. According to some sources, up to 80% of African national borders can be categorized as made up by artificial lines (Alesina et al., 2011). Such artificial borders were drawn because they made it easier for colonial powers to extract resources, exert territorial control, and to maintain political stability (Pierskalla et al., 2017).

With decolonization in the aftermath of World War II, independent nation states emerged on the African continent. These new nations kept the arbitrary national borders drawn up by the colonial powers. Moreover, in their aim to mold their multi-ethnic societies into unified nations and to engage in nation building, most African countries opted for a unitary model of government instead of decentralization and federalism.[5] These decisions reverberate to this day and manifest themselves in substantial ethnic fragmentation within and across political jurisdictions and sub-optimal state organization, both of which have been shown to lie at the heart of the continent's relatively disappointing economic performance since decolonization (Michalopoulos and Papaioannou, 2016).

[5]First, only three African countries (Ethiopia, Nigeria and Sudan) can be characterized as federations (Treisman, 2008). Second, African federalism is considered to be ineffective. National governments generally do not honor the constitutional arrangements and are reluctant to provide autonomy for ethnic minorities (Fessha, 2012).

Given the absence of changes to national borders (except for the secession of Eritrea from Ethiopia in 1993 and South Sudan from Sudan in 2011), subnational border changes by mergers or splits of administrative regions might provide a (partial) remedy for these impediments to development. However, in marked contrast to national borders, little attention has been devoted in the literature to African subnational borders. There is to our knowledge no comprehensive history of subnational border formation and evolution in Africa. Accordingly, little is known about how subnational borders were determined at the dawn of independence as well as why (and why not) they were adjusted during the post-independence history of Africa.

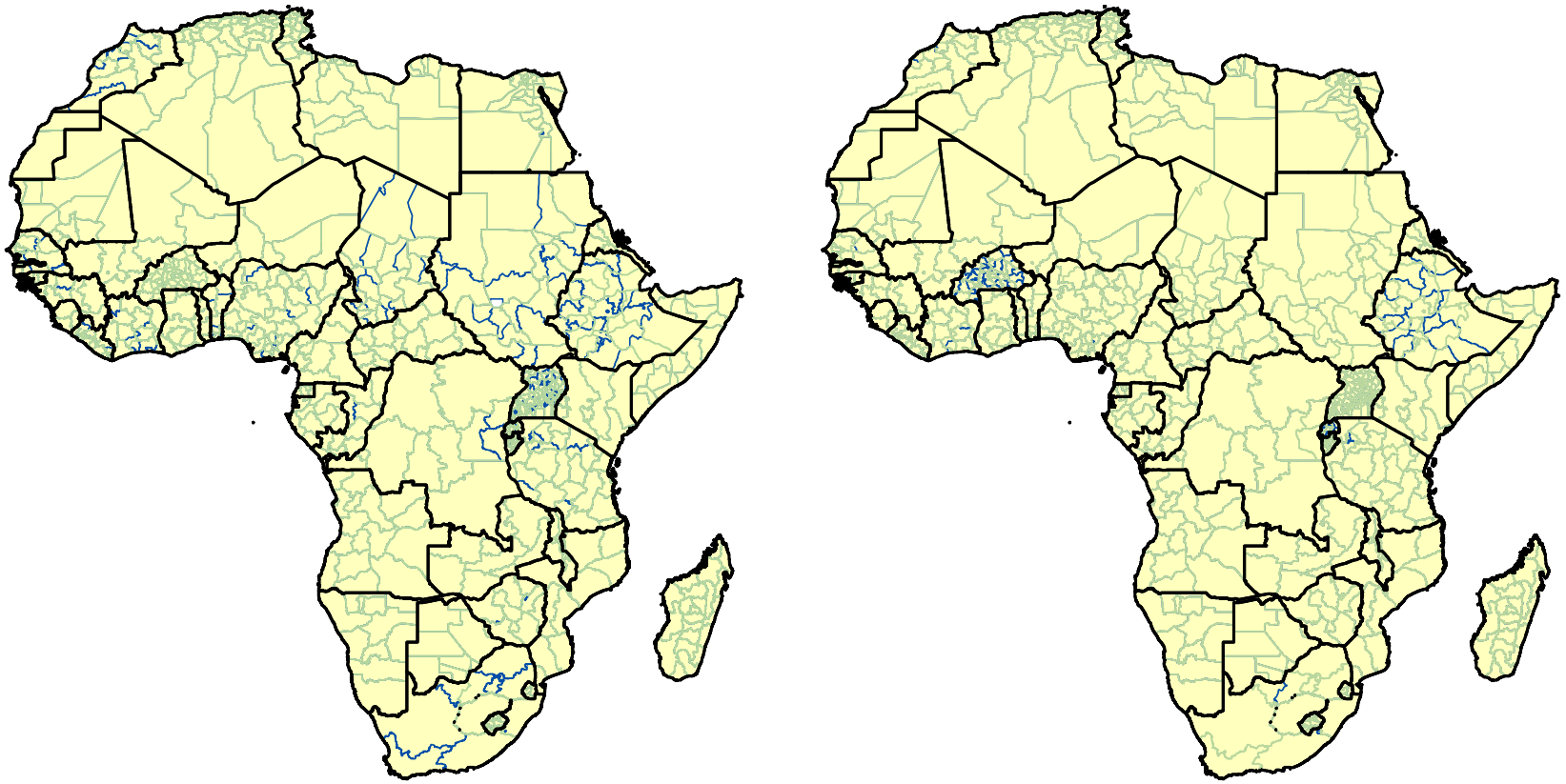
Several pieces of evidence indicate that the subnational borders inherited by African countries were as arbitrary as their national borders. First, there are well-known cases where subnational borders follow longitude or latitude lines, for example in Nigeria, where the British created two regions (northern and southern) for which the common border is at the $7^{\circ}10'$ line of latitude (Berger, 2009).

Second, while subnational border changes have been significantly more common than national border changes across Africa, eyeballing Figure 1, which displays subnational borders in Africa in 1992 and in 2013, respectively, reveals that subnational borders often follow straight lines, both in 1992 and in 2013. Hence, despite all adjustments that have been made after independence, the apparent arbitrary nature of subnational borders persist to this day.

Third, the available anecdotal evidence on the creation of (new) subnational units and the delineation of their boundaries suggests that these were contentious negotiations in which the interests of several stakeholders had to be taken into account. Given that various concerns needed to be simultaneously addressed, it is plausible that the resulting borders were not economically efficient. An example is the creation of the provinces in South Africa during the transition to democracy after Apartheid. Makgetla and Jackson (2010) note that the constitutional committee tasked with the delimitation of the provinces had to balance several political concerns (e. g. to gerrymander the provinces such that influential stakeholders would maximize

their electoral clout as well as to respect the settlement patterns of ethnic and linguistic groups) and the need to create states that were economically viable.[6]

[6]For example, the National Party (NP) supported the creation of the Northern Cape province as its demographics would seem to give it an electoral edge against the African National Congress (ANC) in provincial elections. Makgetla and Jackson (2010) state: "... technical committee members did not envision a Northern Cape, instead drawing a boundary between the Western Cape and North-West province. ANC members on the technical team noted that the Northern Cape had no history of local administration and that the cost of governing the sparse population, coupled with the region's modest local revenue, would make a provincial government's work additionally difficult." In the end, politics trumped the economic concerns and the Northern Cape province was created.



(a) 1992 **(b)** 2013

Figure 1: First-level Subnational borders in Africa in 1992 and 2013. Subfigure (a) overlays the 1992 boundaries (green lines) of first-tier regions over the 2013 boundaries (blue lines). Visible blue lines hence indicate splits in this subfigure. Subfigure (b) overlays the 2013 boundaries (green lines) of first-tier regions over the 1992 boundaries (blue lines). Visible blue lines hence indicate mergers in this subfigure.

2.2 Subnational border reforms in Africa

Reforms of subnational borders have become a common phenomenon in Africa (Grossman and Lewis, 2014).[7] Eyeballing Figure 1, it is obvious that that many countries in Africa changed the borders of their first-tier subnational units between 1992 and 2013. Different types of border changes can be observed. The most straightforward type of border change is the split of an existing region into two or more regions. In these cases, the name of the original region is either retained by one of the new regions or both regions receive new names. The original name is typically retained by one of the new regions if one of the newly created regions is relatively small (i. e. if the split was a secession of a small part of a larger region).

The opposite type of border change is a merger of two or more existing regions into one larger entity. In these cases, either an entirely new region is created or an existing (typically large) region takes over one or more smaller regions.

Finally, more complex forms of border changes have been implemented. In some cases regional boundaries have been completely redrawn. Alternatively, a new first-level tier of government with its own boundaries was superimposed on the existing subnational units. Another variant of a border change is the ceding of small amounts of territory by one region to another region. We provide specific examples of such subnational border changes implemented across Africa below.

According to the GAUL data (we describe this dataset in more detail in Section 3.1.1), the number of regions in 1992 was 685. It has increased to 765 (by 12%) by 2013 (see Figure 2). As discussed, the fact that the number of regions has increased overall during the sample period does not imply that only splits took place – there are various instances of amalgamations, takeovers or other, more complex forms of border changes as well. Table 1 gives an overview of the regions affected by a border change within their territory and the year of the change. These tables also suggests that various countries experienced several border reforms. Moreover, in

[7] See also Table 1 in Grossman and Lewis (2014), which documents general trends in the creation of new subnational units (states, districts and municipalities) in Sub-Saharan Africa. However, Grossman and Lewis (2014) provide no information on mergers of subnational units or other forms of border changes.

Table 1: SUBNATIONAL BORDER CHANGES IN AFRICA

Year	Border Change
1994	Ethiopia, Addis Ababa; Ethiopia, Afar; Ethiopia, Amhara; Ethiopia, Arsi; Ethiopia, Bale; Ethiopia, Beneshangul Gumu; Ethiopia, Gambela; Ethiopia, Gamo Gofa; Ethiopia, Gojam; Ethiopia, Gonder; Ethiopia, Harerge; Ethiopia, Hareri; Ethiopia, Ilubador; Ethiopia, Kefa; Ethiopia, Oromia; Ethiopia, SNNPR; Ethiopia, Shewa; Ethiopia, Sidamo; Ethiopia, Somali; Ethiopia, Tigray; Ethiopia, Welega; Ethiopia, Welo; South Africa, Cape; South Africa, Eastern Cape; South Africa, Gauteng; South Africa, KwaZulu-Natal; South Africa, Limpopo; South Africa, Mpumalanga; South Africa, North West; South Africa, Northern Cape; South Africa, Transvaal; South Africa, Western Cape; Sudan, Al Jazeera; Sudan, Blue Nile; Sudan, Central Equatoria; Sudan, Eastern Equatoria; Sudan, El Buheyrat; Sudan, Gadaref; Sudan, Jonglei; Sudan, Kassala; Sudan, Nile; Sudan, Northern; Sudan, Northern Bahr El Ghazal; Sudan, Northern Darfur; Sudan, Northern Kordofan; Sudan, Red Sea; Sudan, Sennar; Sudan, Southern Darfur; Sudan, Southern Kordofan; Sudan, Unity; Sudan, Upper Nile; Sudan, Warab; Sudan, Western Bahr El Ghazal; Sudan, Western Darfur; Sudan, Western Equatoria; Sudan, Western Kordofan; Sudan, White Nile
1995	Congo, Cuvette; Congo, Cuvette-Ouest
1997	Côte d'Ivoire, Agneby; Côte d'Ivoire, Bas Sassandra; Côte d'Ivoire, Centre; Côte d'Ivoire, Centre-Nord; Côte d'Ivoire, Centre-Ouest; Côte d'Ivoire, Denguele; Côte d'Ivoire, Haut-sassandra; Côte d'Ivoire, Lacs; Côte d'Ivoire, Lagunes; Côte d'Ivoire, Marahoue; Côte d'Ivoire, N'zi Comoe; Côte d'Ivoire, Sud; Côte d'Ivoire, Sud Bandama; Côte d'Ivoire, Sud Comoe; Côte d'Ivoire, Sud-Ouest; Côte d'Ivoire, Vallee Du Bandama; Côte d'Ivoire, Worodougou; Democratic Republic of the Congo, Maniema; Democratic Republic of the Congo, Nord-Kivu; Democratic Republic of the Congo, Sud-Kivu; Morocco, Centre; Morocco, Chaouia - Ouardigha; Morocco, Doukkala - Abda; Morocco, Fès - Boulemane; Morocco, Gharb - Chrarda - Béni Hssen; Morocco, Grand Casablanca; Morocco, Guelmim - Es-Semara; Morocco, Laâyoune - Boujdour - Sakia El Hamra; Morocco, Marrakech - Tensift - Al Haouz; Morocco, Nord Ouest; Morocco, Rabat - Salé - Zemmour - Zaer; Morocco, Souss - Massa - Draâ; Morocco, Tadla - Azilal; Morocco, Tanger - Tétouan; Morocco, Taza - Al Hoceima - Taounate; Morocco, Tensift; Nigeria, Abia; Nigeria, Bauchi; Nigeria, Bayelsa; Nigeria, Ebonyi; Nigeria, Ekiti; Nigeria, Enugu; Nigeria, Gombe; Nigeria, Nassarawa; Nigeria, Ondo; Nigeria, Plateau; Nigeria, Rivers; Nigeria, Sokoto; Nigeria, Zamfara; Zimbabwe, Bulawayo; Zimbabwe, Harare; Zimbabwe, Mashonaland East; Zimbabwe, Matabeleland North
1998	Burundi, Muramvya; Burundi, Mwaro; Ethiopia, Dire Dawa
1999	Benin, Alibori; Benin, Atakora; Benin, Atlantique; Benin, Borgou; Benin, Collines; Benin, Couffo; Benin, Donga; Benin, Littoral; Benin, Mono; Benin, Oueme; Benin, Plateau; Benin, Zou
2000	Chad, Assongha; Chad, Baguirmi; Chad, Barh Koh; Chad, Barl El Gazal; Chad, Batha Est; Chad, Batha Ouest; Chad, Borkou; Chad, Chari Baguirmi; Chad, Daraba; Chad, Ennedi; Chad, Hadjer Lamis; Chad, Kabia; Chad, Kanem; Chad, Lac Iro; Chad, Logone Oriental; Chad, Mandoul; Chad, Mayo Kebi; Chad, Mayo-Boneye; Chad, Mayo-Dala; Chad, Mont De Lam; Chad, Ouaddai; Chad, Sila; Chad, Tandjile Est; Chad, Tandjile Ouest; Chad, Tibesti; Côte d'Ivoire, 18 Montagnes; Côte d'Ivoire, Fromager; Côte d'Ivoire, Haut-sassandra; Côte d'Ivoire, Marahoue; Côte d'Ivoire, Moyen-Cavally; Liberia, Grand Gedeh; Liberia, River Gee
2001	Burkina Faso, Bale; Burkina Faso, Bam; Burkina Faso, Banwa; Burkina Faso, Bazega; Burkina Faso, Bougouriba; Burkina Faso, Boulgou; Burkina Faso, Boulkiemde; Burkina Faso, Comoe; Burkina Faso, Ganzourgou; Burkina Faso, Gnagna; Burkina Faso, Gourma; Burkina Faso, Houet; Burkina Faso, Ioba; Burkina Faso, Kenedougou; Burkina Faso, Komonjdjari; Burkina Faso, Kompienga; Burkina Faso, Kossi; Burkina Faso, Koulpelogo; Burkina Faso, Kouritenga; Burkina Faso, Kourweogo; Burkina Faso, Leraba; Burkina Faso, Loroum; Burkina Faso, Mouhoun; Burkina Faso, Nahouri; Burkina Faso, Namentenga; Burkina Faso, Nayala; Burkina Faso, Noumbiel; Burkina Faso, Oubritenga; Burkina Faso, Oudalan; Burkina Faso, Passore; Burkina Faso, Poni; Burkina Faso, Sanguie; Burkina Faso, Sanmatenga; Burkina Faso, Seno; Burkina Faso, Sissili; Burkina Faso, Soum; Burkina Faso, Sourou; Burkina Faso, Tapoa; Burkina Faso, Tuy; Burkina Faso, Yagha; Burkina Faso, Yatenga; Burkina Faso, Ziro; Burkina Faso, Zondoma; Burkina Faso, Zoundweogo; Côte d'Ivoire, Bafing; Côte d'Ivoire, Worodougou; Liberia, Gbarpolu; Liberia, Lofa
2002	Senegal, Diourbel; Senegal, Matam; Senegal, Saint louis; United Republic of Tanzania, Arusha; United Republic of Tanzania, Manyara
2003	Congo, Kouilou; Congo, Point-Noire; Gambia, Banjul; Gambia, Kombo Saint Mary
2005	Uganda, Budaka; Uganda, Pallisa
2006	Rwanda, Butare; Rwanda, Byumba; Rwanda, Cyangugu; Rwanda, East/Iburasirazuba; Rwanda, Gikongoro; Rwanda, Gisenyi; Rwanda, Gitarama; Rwanda, Kibungo; Rwanda, Kibuye; Rwanda, Kigali City/Umujyi wa Kigali; Rwanda, Kigali-ngali; Rwanda, North/Amajyaruguru; Rwanda, Prefecture De La Ville De Kigali; Rwanda, Ruhengeri; Rwanda, South/Amajyepfo; Rwanda, Umutara; Rwanda, West/Iburengerazuba; Sudan, Northern Kordofan; Sudan, Southern Kordofan; Sudan, Western Kordofan; Uganda, Abim; Uganda, Amuru; Uganda, Apac; Uganda, Arua; Uganda, Buliisa; Uganda, Dokolo; Uganda, Gulu; Uganda, Iganga; Uganda, Kotido; Uganda, Lira; Uganda, Maracha; Uganda, Masindi; Uganda, Namutumba; Uganda, Oyam
2007	Uganda, Bududa; Uganda, Bukedea; Uganda, Kumi; Uganda, Lyantonde; Uganda, Manafwa; Uganda, Rakai
2008	Senegal, Kaffrine; Senegal, Kaolack; Senegal, Kedougou; Senegal, Kolda; Senegal, Sedhiou; Senegal, Tambacounda
2009	Egypt, Luxor; Egypt, Qena; Uganda, Amudat; Uganda, Buikwe; Uganda, Buyende; Uganda, Kamuli; Uganda, Kitgum; Uganda, Kyegegwa; Uganda, Kyenjojo; Uganda, Lamwo; Uganda, Lira; Uganda, Mukono; Uganda, Nakapiripirit; Uganda, Nebbi; Uganda, Otuke; Uganda, Zombo
2010	Uganda, Agago; Uganda, Alebtong; Uganda, Apac; Uganda, Bugiri; Uganda, Buhweju; Uganda, Bukomansimbi; Uganda, Bulambuli; Uganda, Bundibugyo; Uganda, Bushenyi; Uganda, Butambala; Uganda, Buvuma; Uganda, Gomba; Uganda, Iganga; Uganda, Kalungu; Uganda, Kapchorwa; Uganda, Kiboga; Uganda, Kibuku; Uganda, Kiryandongo; Uganda, Kole; Uganda, Kumi; Uganda, Kween; Uganda, Kyankwanzi; Uganda, Lira; Uganda, Luuka; Uganda, Lwengo; Uganda, Masaka; Uganda, Masindi; Uganda, Mitooma; Uganda, Moroto; Uganda, Mpigi; Uganda, Mukono; Uganda, Namayingo; Uganda, Napak; Uganda, Ngora; Uganda, Ntoroko; Uganda, Nwoya; Uganda, Pader; Uganda, Pallisa; Uganda, Rubirizi; Uganda, Serere; Uganda, Sheema; Uganda, Sironko; Uganda, Soroti
2011	Congo, Kouilou; Sudan, Southern Kordofan
2012	Côte d'Ivoire, 18 Montagnes; Côte d'Ivoire, Agneby; Côte d'Ivoire, Bafing; Côte d'Ivoire, District autonome de Abidjan; Côte d'Ivoire, District autonome de Yamoussoukro; Côte d'Ivoire, Fromager; Côte d'Ivoire, Haut-sassandra; Côte d'Ivoire, Lacs; Côte d'Ivoire, Lagunes; Côte d'Ivoire, Marahoue; Côte d'Ivoire, Moyen Comoe; Côte d'Ivoire, Moyen-Cavally; Côte d'Ivoire, N'zi Comoe; Côte d'Ivoire, Sud Bandama; Côte d'Ivoire, Sud Comoe; Côte d'Ivoire, Worodougou; United Republic of Tanzania, Geita; United Republic of Tanzania, Iringa; United Republic of Tanzania, Kagera; United Republic of Tanzania, Katavi; United Republic of Tanzania, Mwanza; United Republic of Tanzania, Njombe; United Republic of Tanzania, Rukwa; United Republic of Tanzania, Shinyanga; United Republic of Tanzania, Simiyu

This table collects all regions with territories affected by border changes (as identifed by the GAUL and Statoids data) and the corresponding year of the border change.

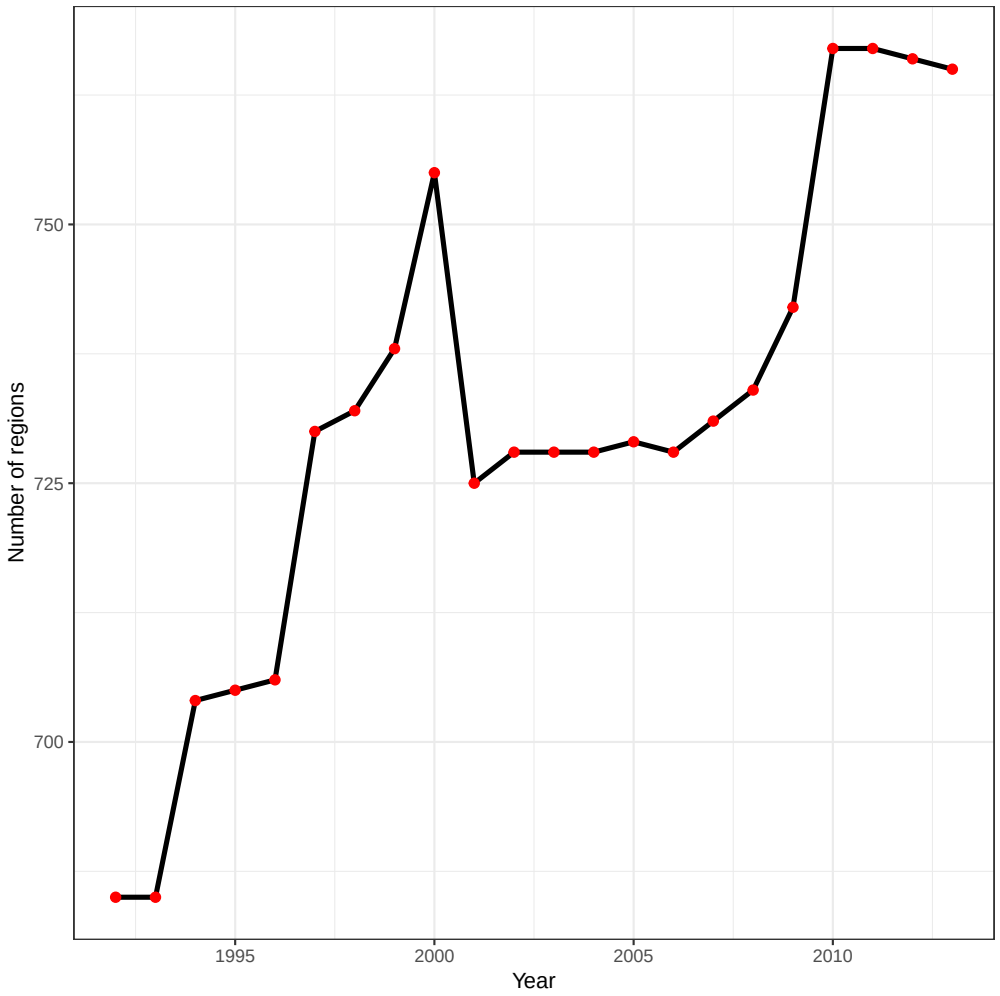


Figure 2: Number of first-level regions in Africa, 1992-2013. This figure shows the development in the number of subnational regions across Africa during the sample period.

some countries, e. g. Egypt or Burundi, border changes were ostensibly isolated events that affected only a few regions. In other countries, for example Buskin Faso and Ethiopia, border changes affected the entire country and were part of broader public sector reforms.

Most border changes in Africa follow a top-down approach given the unitary-centralist nature of African countries. Accordingly, border changes are usually a central government policy imposed on subnational governments. The official reasons given for the border changes are specific to the country in question. In Burkina Faso, for example, a territorial reorganization was initiated in 2001 that saw the introduction of a new tier of government – called regions – that encompassed the old provinces. These changes were part of a wider public sector reform to improve administrative efficiency. In Rwanda, in contrast, the boundaries of the provinces

were completely redrawn in 2006 in a deliberate attempt to reduce the degree of within-region ethnic homogeneity (i. e., to create regions that were ethnically diverse). Border changes were also implemented for reasons that were not always openly proclaimed. For example, some countries appear to have implemented splits to re-centralize power to the national tier as well as to reduce the intergovernmental bargaining power of subnational units (Grossman and Lewis, 2014). It has also been argued that splits were implemented for electoral reasons (Resnick, 2017), in particular to more easily target fiscal transfers from the central government to specific voter groups (Hassan, 2013; Gottlieb et al., 2019), to strengthen relationships with local elites (Green, 2010), or to address ethnic grievances (Pierskalla, 2016).

3 Data and empirical strategy

3.1 Data

3.1.1 GAUL data on border changes

Our data on border reforms is taken from the GAUL project overseen by the UN's Food and Agriculture Organization (FAO). The main objectives of the GAUL project are (i) to provide reliable spatial information on administrative units and (ii) to maintain a historical record of changes that occur to their shapes and extent (GAUL, 2014). The project assembles this information using various official sources and makes it available to the public in the form of GIS shapefiles in which subnational borders are indicated as line features.

In these shapefiles, the emergence or dissolving of a line from one to the next year ostensibly implies some form of redrawing of borders. We use GIS software to systematically track changes to the line features that represent the borders of the first-level subnational units. Line features can change in two ways. First, a line can emerge within a given territory. We classify such changes that effectively bifurcate a given territory as splits. Second, an existing line between two regions may vanish. We classify these types of border changes as mergers. To avoid misunderstandings, note that this terminology of splits and mergers refers to the emergence or

disappearance of border lines within grid cells. Classifying a grid cell as having been exposed to a split or a merger does not necessarily imply that the corresponding subnational region was nominally split or merged (i. e., it could have been subject to other forms of border changes such as a simple redrawing of borders).[8]

For a first illustration, consider again Figure 1. Subfigure (a) overlays the regional boundaries across Africa in 1992 over the boundaries in 2013. The borders in 1992 are colored green while those in 2013 are colored blue (we indicate country borders with black lines). The observable blue lines hence indicate new borders that emerged over the sample period and thereby allow us to identify all splits from 1992 to 2013. Subfigure (b) overlays the regional boundaries in 2013 over those in 1992. In this case, the borders as of 1992 are colored blue and those in 2013 green. Therefore, the blue lines show those borders that vanished over the sample period and hence indicate mergers.[9]

Since we have yearly maps, we can identify the year in which a particular region was split or merged through GIS methods. To illustrate our year-by-year algorithm, consider Figures A.1 and A.2 in the appendix. Subfigure (a) in both figures displays the GAUL map of subnational

[8]For example, a border change where a region cedes small amounts of territory to another already existing region could be classified as a split from the perspective of the ceding region. From the perspective of the receiving region, this border change could be classified as a merger (as it receives additional territory). By focusing on border lines within cells rather than on the regions themselves, we avoid such classification issues.

A cell could be simultaneously subject to both the emergence and disappearance of a border line, e. g., when a border is slightly redrawn. Cells would then be classified as having simultaneously been subject to both splits and mergers. In general, both splits and mergers can be part of the same border reform and, as such, could have similar implications for economic development.

[9]Note that the comparison between the maps of 1992 and 2013 does not reveal all border changes during the sample period. In some cases, regions were e. g. split and then merged again with other regions, such that borders only existed during an interim period. For example, the state of Kordofan in Sudan was split in 1994 into three states: South, North, and West Kordofan. West Kordofan was subsequently abolished in 2005/2006 as a state and its territory divided up between South and North Kordofan. Thus, only comparing the maps of 1992 and 2013 would not reveal the splits and mergers that affected West Kordofan. We thus rely on yearly maps to identify border changes.

regions in western Africa for 2000, while subfigure (b) displays the map of subnational regions as of 2001.

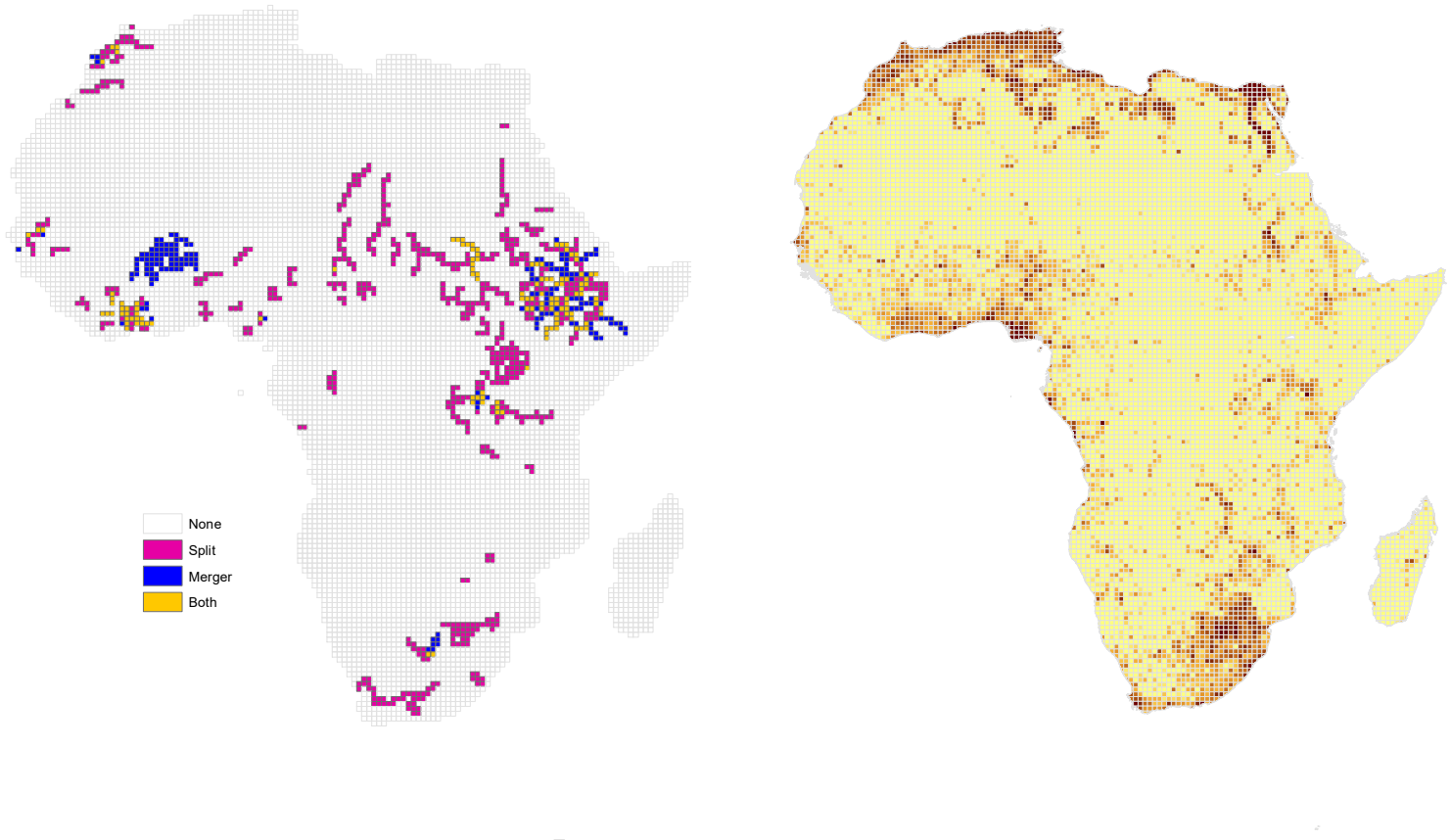
In Figure A.1, the lines that newly emerged in 2001 are highlighted in red (the affected countries were Cote d'Ivore and Liberia). As mentioned above, we classify these line features as splits. In Figure A.2, all line features that vanished from 2000 to 2001 are highlighted in red (the only affected country was Burkina Faso). Again as mentioned above, we classify these line features as mergers. We retrieve these changes to the line features representing borders for each year in order to subsequently define which territories across Africa were exposed to mergers or splits in a given year.

While the data provided by the GAUL project is not validated by official national sources, it has generally been found to be complete and accurate, particularly for Africa (Brigham et al., 2012). Nevertheless, after compiling the list of splits and mergers of subnational regions using the GAUL data as described above, we cross-check this list with the descriptive information on subnational regions provided on an updated online supplement (`www.statoids.com`) to Law (1999). We find that almost all border changes identified by the GIS-based method using the GAUL maps are reflected on this database. We delete 21 (out of 371) cases where the GIS-based splits and mergers were not referenced on `www.statoids.com`, i. e. delete these cases from our list of border changes.[10]

After identifying the line features that indicate splits and borders and validating them, we project the emerging (in case of splits) or vanishing (in case of mergers) line to a 0.5×0.5 degree (about 55km^2) grid of cells covering all of the African continent (i. e. the PRIO-grid 2.0, see `https://grid.prio.org/`). As discussed in the introduction, unlike the subnational regions themselves, the 0.5×0.5 degree cells can serve as time-constant units of analysis for the regressions exploring the impact of border changes on economic development below.

[10]The main discrepancy between the GAUL data and `www.statoids.com` is, in fact, that the year in which a border change is recorded differs in some instances by one year. Naturally, given that border changes can take time, there is some leeway in how the year of their occurrence is recorded. In cases of discrepancy, we use the year as identified by the GAUL maps.

Based on the projection of border changes to the grid of cells, we classify cells as being subject to a split or a merger in a given year. Consider subfigure (a) of Figure 3 which shows how Africa is divided into the 0.5×0.5 degree cells. Cells are colored depending on whether they were at least once affected by splits or mergers over the sample period. As suggested by our discussion in Section 2, and in line with Figure 1, we observe that more cells were subject to splits than mergers (i. e. more border lines appear than disappear during the sample period). There is also a number of cells where the corresponding territory was subject to both at least one split and one merger.



(a) BORDER REFORMS **(b)** NIGHT LIGHT OUTPUT

Figure 3: Border reforms and light output at the grid-level. Subfigure (a) shows the cells affected by a split, merger, or both during the sample period. Subfigure (b) shows average night light output of each cell over the sample period.

3.1.2 Luminosity as proxy for economic development

Following previous literature, we use nighttime luminosity as a proxy for development at low levels of geography (Alesina et al., 2016; Hodler and Raschky, 2014; Michalopoulos and Papaioannou, 2016; Bruederle and Hodler, 2018). This data is based on images of the earth at night obtained by satellites of the US Air Force (USAF) Defense Meteorological Satellite Program Operational Linesman System (DBMS-OLD). The original imagery is processed by the National Oceanic and Atmospheric Agency (NOAA) and is released to the public as raster datasets.

The raster datasets consist of annual average stable night lights between 8.30pm to 10pm and are available at a resolution of 30 arc-seconds (about 0.86 square kilometer at the equator) for all years after 1992. Each cells of the dataset stores a digital value ranging from 0 to 63 indicating the amount of average light of an area covering 30 arc-seconds. Higher values imply that a cell emanates more light (Henderson et al., 2012).

To obtain a proxy for cell-level GDP, we overlay the grid of cells over the raster datasets and calculate the sum of the digital values of each cell with size 30 arc-seconds that falls within the boundaries of each of the 0.5 $\times$ 0.5 degree cells as shown in subfigure (a) of Figure 3. Subfigure (b) plots average night lights over the sample period in each of these cells. More strongly shaded cells indicate higher luminosity. In general, the pattern of cell-level luminosity matches with anecdotal evidence of African development. For example, coastal areas tend to have higher luminosity than the hinterland.

3.2 Empirical strategy

To estimate the effect of border changes on local development, we implement a difference-in-differences design using the 0.5 $\times$ 0.5 degree cells as units of observations. The basic specification is:

$$y_{i,t} = \alpha_i + \gamma_{c,t} + \beta \text{Border Change}_{i,t} + \varepsilon_{i,t}, \tag{1}$$

where $y_{i,t}$ is log of cells-level aggregate night light output in cell i in year t.[11] *Border Change* is a dummy that is one for all $T \leq t \leq 2013$ after a change to feature lines in the GAUL files within the territory covered by a particular cell (i. e., from the first year in which a cell is affected by a border change until the end of the sample period).[12] As discussed, changes to feature lines can be classified further as splits (emergence of a new feature line) or as mergers (vanishing of a feature line).

To account for country-wide year-specific effects, we include country-specific year fixed effects $\gamma_{c,t}$.[13] (Country-specific) Year fixed effects also account for annual variations in measured night light output due to different calibrations of the satellites used to record luminosity. To control for systematic (but time-invariant) differences between cells, we include cell fixed effects (α_i). For hypothesis tests, we always rely on heteroscedasticity-robust standard errors that are clustered at the level of the cells.

We estimate this model over the period 1992-2013 using the entire sample of cells covering Africa. However, we drop all cells covering Ethiopia / Eritrea before 1993 (before Eritrea seceded from Ethiopia) and cells covering Sudan / South Sudan after 2010 (since South Sudan seceded from Sudan). See Figure A.3 for the number of cells within each country in the sample.

As usual with difference-in-differences designs, the identifying assumption is that treated and control cells would have had common trends in the absence of treatment. This identifying assumption is important in our context as border changes do not take place randomly. To address this, we first rely on the country-specific year fixed effects, which account for country-level determinants of border changes. Second, we report below results from event-study type regressions where we can observe whether there are any trends in nighttime luminosity systematically preceding border changes.

[11] For cells that have a value of 0 for aggregate night light output, we add +0.01 before taking the log.

[12] Note that by this definition of the treatment dummies, we implicitly account for the (few) cells affected by border changes in two separate years.

[13] In cases where cells cover more than one country, we assign a cell to the country that covers the largest portion of its area.

A recent literature shows that the canonical two-way fixed effects estimator may lead to biased estimates if the adoption of the treatment is staggered and treatment effects are heterogeneous (Athey and Imbens, 2022; de Chaisemartin and D'Haultfoeuille, 2020; Sun and Abraham, 2021). Naturally, the border changes we study take place at different points in time and have plausibly heterogeneous effects. Different approaches have been proposed to address the bias of the traditional two-way fixed effects estimator in such settings (Roth et al., 2022). We use the two-step approach by Gardner (2021) which is suitable for binary treatments with staggered rollouts.[14] Another major advantage of Gardner's (2021) approach is computational feasibility, which is a relevant consideration in our context given our relatively large sample and numerous fixed effects (see Equation 1).

In Gardner's (2021) two-step approach, the group and and year-specific effects are estimated in the first step with the sample of untreated observations. In a second step, the treatment effect is computed by comparing treated and untreated observations after accounting for the group and year-specific effects estimated in the first step.

4 Results

Baseline Table 2 collects the baseline results. In column 1, we first estimate a specification that relates generic border changes (irrespective of whether we classify them as splits or mergers) to luminosity. The results indicate a significantly positive effect of border changes. Cells that were affected by a border change witness in the long-run an increase in luminosity by about 25%. Using the elasticity between night-lights and GDP of 0.3 estimated by Henderson et al. (2012), these estimates imply that mergers cause a long-run increase in GDP by about 7.5%.

In column 2 and 3, we differentiate border changes into splits and mergers, i. e., whether a border change refers to the disappearance or appearance of a border line within a given cell.

[14] Specifically, the R implementation by Butts (2021).

Both splits and mergers have a positive effect on luminosity, even if the effect of mergers is larger than the effect of splits.[15]

Overall, these results suggests that subnational border reforms in Africa generally improved local economic outcomes in the cells where border lines were changed. Results reported below (at the regional level) also suggest that this is a net-effect, i. e., that it does not come about at the expense of interior areas due to a relocation of local economic activity to border areas.

Table 2: BORDER CHANGES AND ECONOMIC DEVELOPMENT IN AFRICA: BASELINE

	(1)	(2)	(3)
Border Change	0.2541***		
	(0.0943)		
Split		0.2027**	
		(0.0922)	
Merger			0.4710**
			(0.1966)
Cells	10,667	10,667	10,667
Observations	231,692	231,692	231,692
Adjusted R^2	0.00112	0.00059	0.00127

[a] This table collects results from difference-in-difference regressions following Gardner (2021) that relate border changes in Africa to the log of night light output. The units of observation are 0.5 × 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.
[b] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).
[c] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

Event-study Next, we report results from event-study regressions. The main purpose of these specifications is to asses how quickly the economic benefits of border changes emerge, and thus to gain a more comprehensive understanding of how border changes affect economic

[15] We report in Table A.2 results from traditional difference-in-differences regressions in the appendix. The results point in the same direction, but are insignificant in the case of splits and, in turn, for the generic border change specification as well.

development. In addition, event studies can help us to evaluate whether border changes are induced by divergent economic development across regions within countries.

We estimate models where we include all pre- and post-treatment years for cells that were affected by splits and mergers, relying again on the two-step procedure by Gardner (2021) to account for staggered treatments and heterogenous treatment effects. Figure A.4 in the appendix shows the number of observations available for the estimation of each pre- and post-treatment coefficient for splits and mergers, respectively.

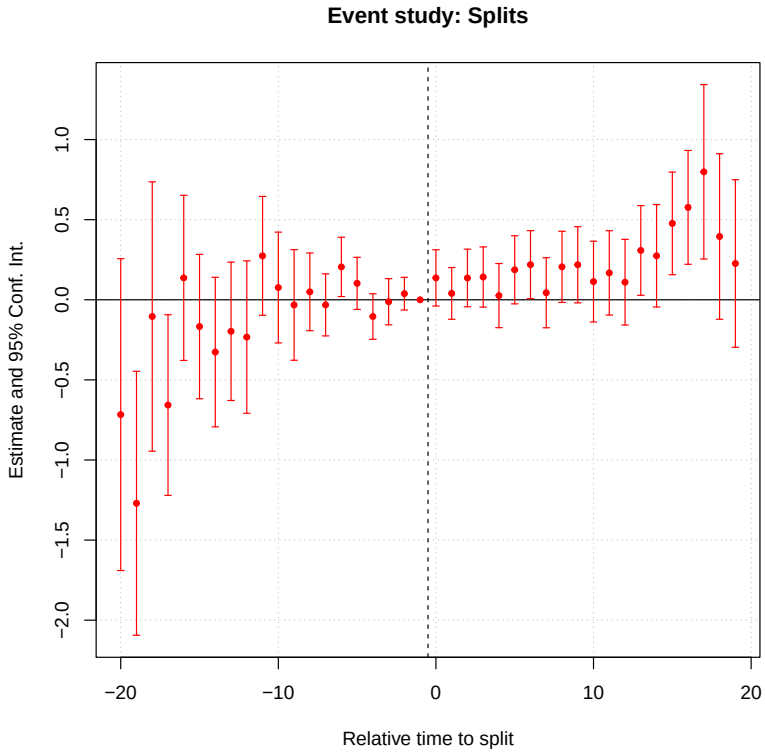
The coefficient estimates for splits are collected in subfigure (a) of Figure 4. We observe no strong trend before splits, suggesting that there were no systematic differences in the economic trajectories of cells affected and not affected by splits. Second, after a split takes place, we observe a small, but noticeable long-run up-ward trend in night lights. The coefficient appears to decline starting in t=18, but there is also a noticeable drop in treated observations around this time as per subfigure (a) of Figure A.4.

Subfigure (b) reports the results for mergers. After a merger, luminosity begins to slowly increase over time. It remains significantly higher than in the pre-treatment period after 20 years. However, the long-term effects should be interpreted with caution given that the composition of the sample ostensibly changes during this long period.

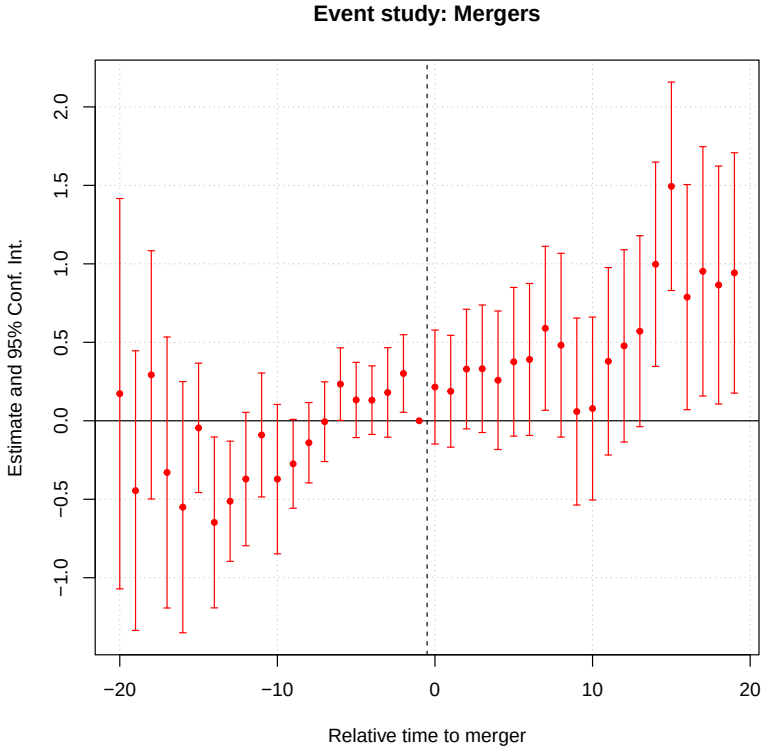
We also observe a flat pre-treatment trend at least for five years before the onset of treatment. There is an increase between t-10 to t-5, but this increase is difficult to interpret. Subfigure (b) of Figure A.4 shows an increase in year t-10 as well as in t-5 in the number of observations for the estimation of the pre-merger coefficients, indicating that the increase in luminosity in the period t-10 to t-5 might be, in fact, due to the changing composition of the sample.[16]

Region-level estimates While we implement our baseline specifications at the cell-level, it is plausible that treatment effects differ between cells immediately at the border and cells located

[16]We report event-studies using the traditional approach in Figure A.5 in the appendix. The event-study plots with the traditional approach for both splits and for mergers are similar to those obtained with Gardner's (2021) approach.



(a) SPLITS



(b) MERGERS

Figure 4: Event-study of splits and mergers. This figure shows event study plots at the cell-level for splits and mergers covering pre- and the post-treatment periods. The whiskers indicate the 95% confidence intervals. Standard errors are robust to heteroscedasticity and clustered at the cell-level.

Table 3: BORDER CHANGES AND ECONOMIC DEVELOPMENT IN AFRICA: TREATMENT EFFECTS AT THE REGIONAL LEVEL

	(1)	(2)	(3)
Border Change	0.3587***		
	(0.0681)		
Split		0.0342	
		(0.0866)	
Merger			0.6141***
			(0.0740)
Cells	685	685	685
Countries	48	48	48
Adjusted R^2	0.020	0.000	0.034

[a] This table collects results from difference-in-difference regressions following Gardner (2021) that relate border changes in Africa to the log of night light output. The unit of observation are 0.5 × 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.
[b] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).
[c] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

in the interior of the same region. After all, border changes affect the region whose borders were changed as a whole. As such, it is useful to complement the cell-level evidence with estimates where the unit of analysis is the region. However, as discussed above, a region-level analysis of border reforms is made difficult by the fact that regions experiencing a border reform typically cease to exist in their current form.

We circumvent this issue by using regions in their boundaries as of 1992 as units of analysis to re-estimate the baseline specification in Equation 1. The results from this robustness test are collected in Table 3. We continue to find a strong positive effects using the generic border change dummy and the merger dummy. For splits, however, the estimate is small and insignificant. One reason for this result might be that splits are more common within larger subnational units. In such large units, any localized positive effect of a border change might be too small to matter at the aggregate level. In any case, there is no evidence indicating that interior cells are negatively affected by border changes. The effect found with the baseline specifications at the grid level (Table 2) can thus be interpreted as a net-positive effect.

5 Heterogeneity analysis

In this section, we explore whether border changes exhibit heterogeneous treatment effects that depend on country-level characteristics or on the (officially stated) motive behind a subnational border reform. This analysis will then guide our subsequent discussion of mechanisms.

5.1 Border reforms and country-level institutional quality

We first study the link between country-level institutions and the effectiveness of border changes. We focus on three key characteristics: the degree of state capacity, the prevalence of instability and conflicts, and the extent of democracy. For the first two characteristics, we use the "government effectiveness score" and the "aggregated political stability and absence of violence score", respectively, from the International Country Risk Guide (ICRG) database developed and maintained by the PRS Group. The ICRG scores are normalized between 0 and 1, with higher values indicating more government effectiveness (notably bureaucratic quality) and more political stability and fewer conflicts.[17] To measure democracy, we use the value of the Polity2 variable (a revised combined POLITY Score) from the Polity IV database. The Polity2 variable ranges from -10 to +10, with higher values indicating "more democratic" governance. Appendix Table A.1 reports the country-level averages of these variables during the sample period.[18]

The empirical model we estimate is as follows:

$$y_{i,t} = \alpha_i + \gamma_{c,t} + \beta_s \text{Border Change} \times \text{High/Low Institutional Quality}_{i,t} + \varepsilon_{i,t}, \qquad (2)$$

where *High/Low Institutional Quality* are dummies that are one for a country if the country-specific average value of the relevant measure during the sample period was above/below the average over all countries, respectively.

[17] The political stability and absence of violence score is an aggregated score consisting of the individual scores for government stability, internal conflict, external conflict, and ethnic tensions.

[18] Note that the ICRG scores are unavailable for some countries in our sample.

Table 4: SPLITS AND ECONOMIC GROWTH IN AFRICA: INTERACTIONS WITH INSTITUTIONAL QUALITY

	(1: Government Effectiveness)	(2: Political Violence)	(3: Democracy)
Panel A: Higher quality institutions			
Split	0.2831*	-0.0259	-0.0278
	(0.1507)	(0.1390)	(0.1480)
Cells	9,418	9,418	10,450
Countries	37	37	46
Panel B: Lower quality institutions			
Split	0.1497	0.3360**	0.3190***
	(0.1299)	(0.1329)	(0.1195)
Cells	9,418	9,418	10,450
Countries	37	37	46

[a] This table collects results from difference-in-difference regressions following Gardner (2021) that relate splits in countries with high/low institutional quality (government effectiveness (model 1), the absence of political violence (model 2), and the level of democracy (model 3)) to the log of night light output. The units of observation are 0.5 $\times$ 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.

[b] The treatment dummy is the interaction of the dummy indicating splits with a dummy for countries with an average value for the relevant index (across all available years) that is above/below the average value of the index for institutional quality across all countries and years.

[c] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).

[d] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

The results for splits are collected in Table 4 and for mergers in Table 5. First, we find that both types of border changes lead to more economic activity in countries with higher government effectiveness (model 1). Second, border changes affect economic activity more strongly in countries with more political instability and conflict (model 2). Third, they are more effective in less democratic countries (model 3). Overall, these results suggest that subnational border changes are particularly effective if they are implemented in less democratic countries but with high state capacity and in contexts with high instability.

Table 5: MERGERS AND ECONOMIC GROWTH IN AFRICA: HETEROGENEITY BY INSTITUTIONAL QUALITY

	(1: Government Effectiveness)	(2: Political Violence)	(3: Democracy)
Panel A: Higher quality institutions			
Merger	0.6779***	-0.0217	-0.2065
	(0.2374)	(0.3858)	(0.2260)
Cells	9,418	9,418	10,450
Countries	37	37	46
Panel B: Lower quality institutions			
Merger	0.0844	0.7125***	0.5586**
	(0.3756)	(0.2344)	(0.2257)
Cells	9,418	10,450	9,418
Countries	37	46	37

[a] This table collects collects results from difference-in-difference regressions following Gardner (2021) that relate mergers in countries with high/low institutional quality (government effectiveness (model 1), the absence of political violence (model 2), and the level of democracy (model 3)) to the log of night light output. The units of observation are 0.5 $\times$ 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.

[b] The treatment dummy is the interaction of the dummy indicating mergers with a dummy for countries with an average value for the relevant index (across all available years) that is above/below the average value of the index for institutional quality across all countries and years.

[c] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).

[d] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

5.2 Border reforms and country-specific characteristics

We now explore whether the economic effect of subnational border changes depends on fundamental country-specific characteristics, notably on their level of development as measured by their GDP per capita, their population size, and their land area. For example, the effect of border changes for development might be less pronounced in richer countries as the potential for further development might be smaller. One the other hand, subnational border reforms might be more effective in larger and more populous countries, as an efficient territorial organization likely matters more in such contexts.

To explore such heterogeneity, we estimate specifications of the following form:

Table 6: BORDER CHANGES AND ECONOMIC DEVELOPMENT IN AFRICA: HETEROGENEITY BY COUNTRY CHARACTERISTICS

	(1: High GDP)	(2: Low GDP)	(3: Large Population)	(4: Small Population)	(5: Large area)	(6: Small area)
Panel A: Splits						
Split	-0.0167	0.2605**	0.2480**	-0.0087	0.3133***	-0.2210
	(0.1994)	(0.1030)	(0.1055)	(0.1736)	(0.1088)	(0.1527)
Cells	9,606	9,606	10,557	10,557	10,557	10,557
Countries	42	42	46	46	46	46
Panel B: Mergers						
Merger	-0.2227	0.5139**	0.6494***	-0.1040	0.6961***	-0.0645
	(0.1484)	(0.2061)	(0.2148)	(0.4527)	(0.2315)	(0.3659)
Cells	9,606	9,606	10,557	10,557	10,557	10,557
Countries	42	42	46	46	46	46

[a] This table collects results from difference-in-difference regressions following Gardner (2021) that relate border changes in Africa to the log of night light output. The unit of observation are 0.5 × 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.
[b] The treatment dummies are interactions of the dummy for mergers and splits, respectively, with a dummy for countries with an value for the relevant country characteristic that is above/below the average value of the characteristic across all countries in 1991.
[c] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).
[d] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

$$y_{i,t} = \alpha_i + \gamma_{c,t} + \beta_s \text{Border Change} \times \text{Country characteristics}_{i,t} + \varepsilon_{i,t}, \tag{3}$$

with *Country characteristics* are dummy variables indicating whether a country was richer or poorer, more or less populous, or larger or smaller, respectively, than the average country in 1991, i. e., before the start of the sample period.

The results are collected in Table 6. We find that it is poorer, larger and more populous countries that benefit the most from border changes. Treatment effects are only significant for these countries. These findings are consistent with the ideas discussed above, particularly that changes to subnational borders are effective in larger and more populous countries as prevailing regions in Africa might be too large.

5.3 Country-specific effects

Given that country-level variables appear to influence the economic efficacy of border changes, we report in this section country-specific treatment effects for the countries with border changes during the sample period.[19] More specifically, we estimate the following specifications:

[19] One exception is that we do not report results for mergers in Gambia because it is covered by two cells only. As such, no meaningful standard errors can be calculated.

$$y_{i,t} = \alpha_i + \gamma_{c,t} + \beta_s \text{Border Change} \times \text{Country}_{i,t} + \varepsilon_{i,t}, \tag{4}$$

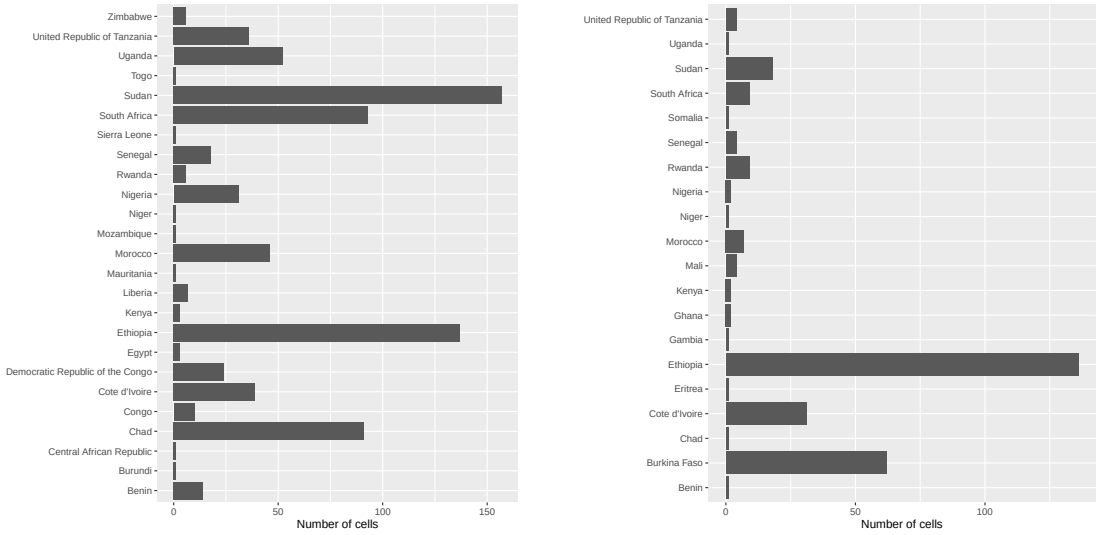
with *Country* a dummy that is, in turn, one for each country with a split or merger, respectively.

Figure 5 shows the number of cells per country affected by splits (subfigure a) or mergers (subfigure b). It is apparent that the number of affected cells varies across countries as well as between splits and mergers. Ethiopia, Sudan and Tanzania, in particular, contribute many cells to the estimation of the treatment for either splits or mergers. Other countries with border changes have only few affected cells, either because they are small or border changes were rare and isolated events.

The results for splits are collected in subfigure (a) of Figure 6. In line with the results discussed in Section 5.2, there is considerable country-level heterogeneity. While splits in Ethiopia, Sudan or Tanzania have large positive effects, their effect in most other countries is close to 0. In several countries - notably Egypt, Liberia, Burundi, and Zimbabwe – splits even appear to have had negative effects. Since Ethiopia, Sudan and Tanzania have many cells affected by splits, the effect estimated by the baseline specification (Table 2) is ostensibly heavily influenced by the effect in these three countries.

The results for mergers are collected in subfigure (b) of Figure 6. They, too, suggest significant country-level heterogeneity. Mergers are particularly effective in Ethiopia, Sudan, and Tanzania, but less effect or even counter-productive for local development in other countries.

It is, of course, difficult to pinpoint what features of these three countries make subnational border changes particularly effective when implemented. One the one hand, these countries do not stand out in terms of their institutions. Compared to other countries in Africa, they are neither particularly democratic or authoritarian, nor particularly violent or peaceful, nor do they display strong or weak state capacity (See Figure A.1). On the other hand, a common trait of these three countries is that they are relatively large and populous. In line with the result above



(a) CELLS WITH SPLITS **(b)** CELLS WITH MERGERS

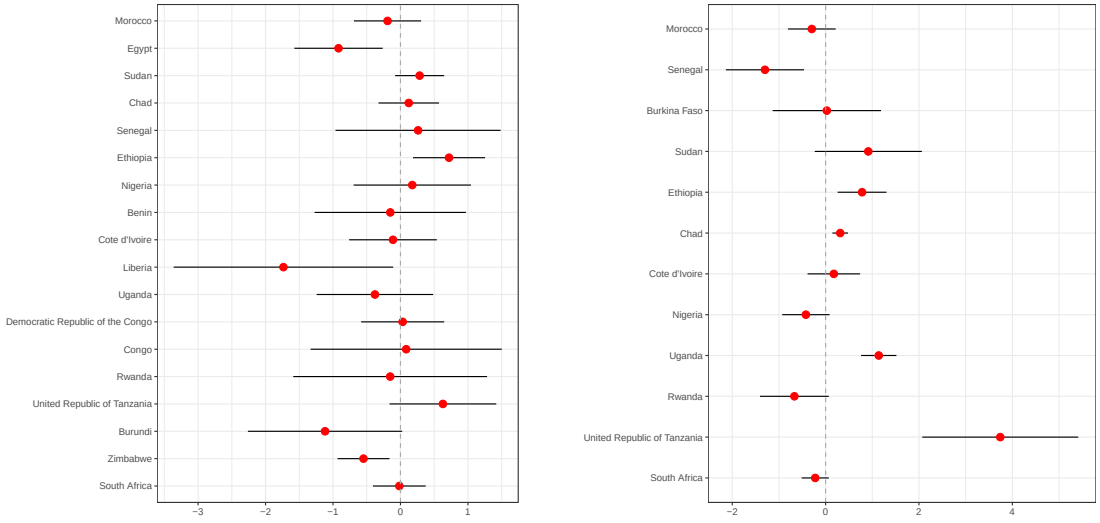
Figure 5: Number of cells affected by border changes across countries.This figure shows the number of cells per country that experienced splits (subfigure a) and the number of cells per country that experienced mergers (subfigure b)

indicating larger and less developed countries benefit more from subnational border changes, it might be that their regions were historically too large and their borders inefficiently drawn.

5.4 Border reforms and their motives

Finally, we study whether the effects of mergers and splits on economic development depend on the (official) reason for their implementation.[20] We explore border changes that (i) were part of a major public sector reform, (ii) border changes that (at least nominally) were implemented to increase administrative efficiency, (iii) border changes in the context of decentralization re-

[20]We hand-collected this data using various online sources and newspaper articles. Of all region-year observations with mergers (splits), about 82.7% (73.5%) were (officially) implemented for administrative reasons, 85.0% (84.8%) as part of a major public sector reform, 83.4% (71.5%) as part of a drive for more decentralization, and 7.9% (2.5%) to change ethnic distribution within regions. Note that some border changes had several motives according to the available public sources. Thus, the numbers listed above do not add up to 100%. Official (or publicly communicated) motives can, of course, differ from true motives for a given border reform.



(a) SPLITS **(b)** MERGERS

Figure 6: Country-specific effects of border changes. This figure shows the country-specific effect of splits (subfigure a) and mergers (subfigure b). Coefficient estimates are indicated with red dots. The whiskers cover the 95% confidence intervals. Standard errors are robust to heteroscedasticity and clustered at the level of cells. Gambia is omitted from the figure for mergers as it is covered by only two cells (no standard errors can be calculated for Gambia).

forms, and (iv) border changes to change the ethnic markup of regions (notably to increase the level of ethnic fragmentation)[21]. The empirical model is as follows:

$$y_{i,t} = \alpha_i + \gamma_{c,t} + \beta_s \text{Border Change} \times \text{Motive}_{i,t} + \varepsilon_{i,t}, \tag{5}$$

[21]The main case for these types of border reforms is Rwanda and Sudan. Rwanda implemented a set of comprehensive border changes in 2006 to reduce ethnic homogeneity within its subnational units, ostensibly with the hope to eventually dilute ethnic identities and thus mitigate the historical conflicts between the two main ethnicities in Rwanda (see `http://news.bbc.co.uk/2/hi/africa/4577790.stm`) No major inter-ethnic conflicts have been reported in Rwanda afterwards.

In Sudan, boundaries in the centrally located region of Kordofan were redrawn in 2006 following the Comprehensive Peace Agreement (CPA) signed between Sudan's national government and the Sudan People's Liberation Movement. In particular, the ethnically homogeneous state of West Kordofan, inhabited by Misseriya Arabs, was abolished and merged with South Kordofan.[22] While the CPA did not lead to a lasting solution to the conflict, it resulted in a interim period of relative stability (De Alessi, 2013).

Table 7: BORDER CHANGES AND ECONOMIC DEVELOPMENT IN AFRICA: HETEROGENEITY BY MOTIVE OF BORDER CHANGE

	(1: Major Reform)	(2: Admin Efficiency)	(3: Decentralization)	(4: Ethnic Distribution)
Panel A: Splits				
Split	0.2462**	0.2268**	0.2330**	1.400***
	(0.0994)	(0.0994)	(0.1006)	(0.4327)
Cells	10,667	10,667	10,667	10,667
Countries	48	48	48	48
Panel B: Mergers				
Merger	0.5189**	0.5059**	0.5128**	0.6375
	(0.2054)	(0.2050)	(0.2061)	(0.4462)
Cells	10,667	10,667	10,667	10,667
Countries	48	48	48	48

[a] This table collects results from difference-in-difference regressions following Gardner (2021) that relate border changes in Africa to the log of night light output. The unit of observation are 0.5 × 0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.

[b] The treatment dummies are interactions of the dummy for either splits or mergers with a dummy for the relevant (official) motive for a border change: either a border change to increase administrative efficiency (model 1), a border change in the context of a major administrative reform (model 2), a border change in the context of a decentralization reform (model 3), or a border change to deliberately change the ethnic distribution of subnational regions (model 4).

[c] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).

[d] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.

where *Motive* is a dummy variable that is one if the corresponding border change was implemented for each of the three reasons discussed above.

The results are collected in Table 7. We find that the official reason for a border change is essentially irrelevant for the estimated efficacy of border changes. While there is some variation across models, the estimates are roughly similar to the baseline estimates. One possible exception are splits intended to change the ethnic distribution of regions. These splits appear to have a larger treatment effect than the other types of border changes. However, since only about 2.5% of splits were implemented for this reason in our sample (see footnote 20), these estimates might not generalize.

6 Conclusion

In this paper, we study the economic consequences of subnational border changes in Africa. Tracking all changes to the borders of first-level subnational units during 1992-2013 across all

of Africa, we find that areas which were affected by a border change – i. e., the emergence or the disappearance of a border line – experience on average stronger economic development as measured by nighttime luminosity.

However, we also uncover significant heterogeneity. While the nominal reason for the border change does in general not matter, border changes turn out to be particularly effective in large, populous and poorer countries. In terms of institutional variables, they are effective if implemented in relatively authoritarian contexts by governments with high administrative capacity. Exploring heterogeneity further on a country-by-country basis, we identify three countries – Ethiopia, Sudan, and Tanzania – which are mainly responsible for the positive treatment effect. Other countries display no or even negative effects after border changes.

Our results suggest that border changes in Africa can be economically advantageous. Yet, the country-level heterogeneity we uncover indicates that the specific context in which they are implemented is important. Countries where border changes have been particularly effective are relatively large and exhibit high state capacity, but they are also authoritarian. Further research should attempt to understand, ideally on a country-by-country basis, which of the many traits by which countries differ make subnational border changes more or less effective in promoting local development. Are democratic governments less able to enforce economically efficient subnational borders as they have to account for other concerns of the affected citizens? Are subnational units in large countries too large and thus, on average, benefit from border readjustments that eventually make these units smaller? Answers to these questions can help policy makers to decide when and when not to pursue subnational border changes.

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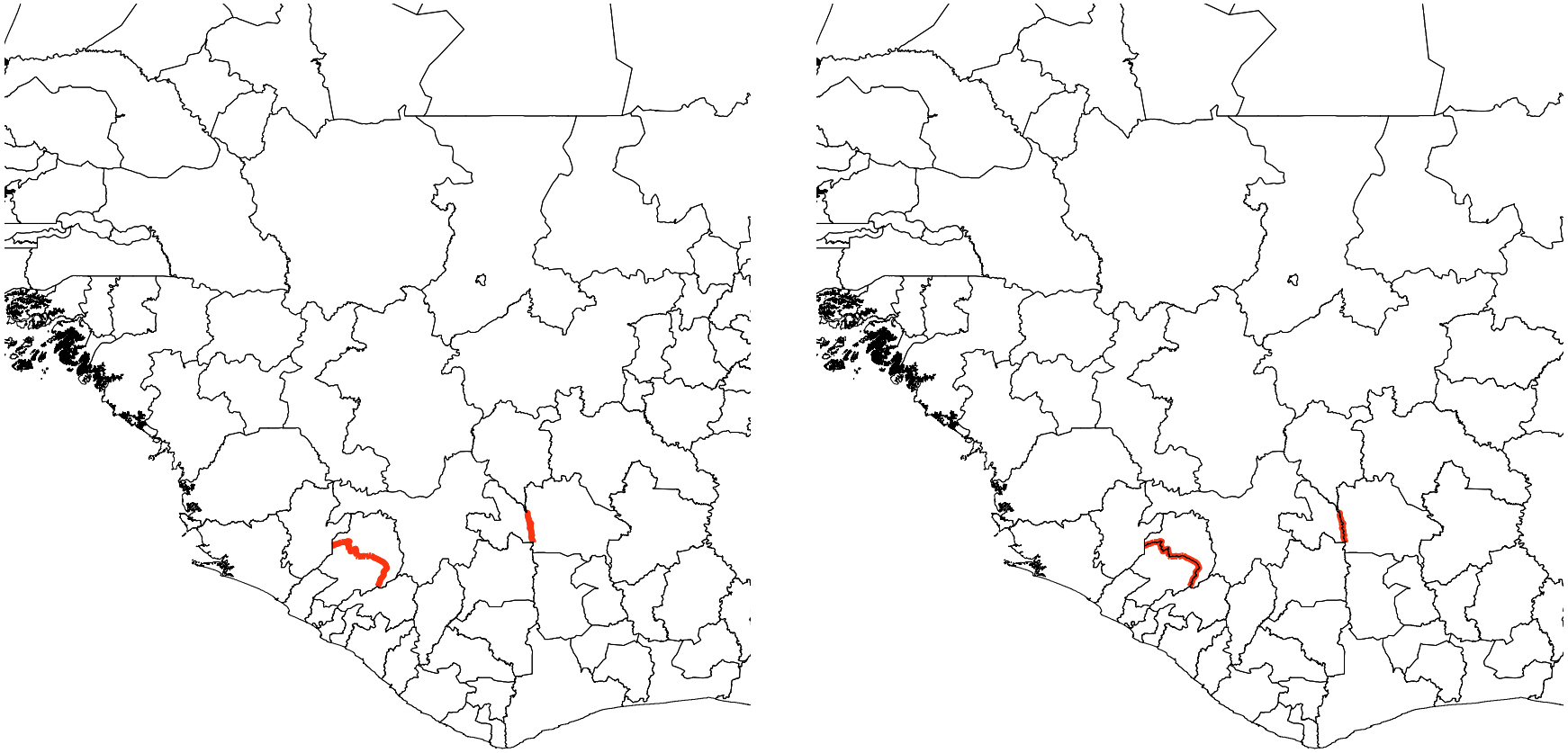
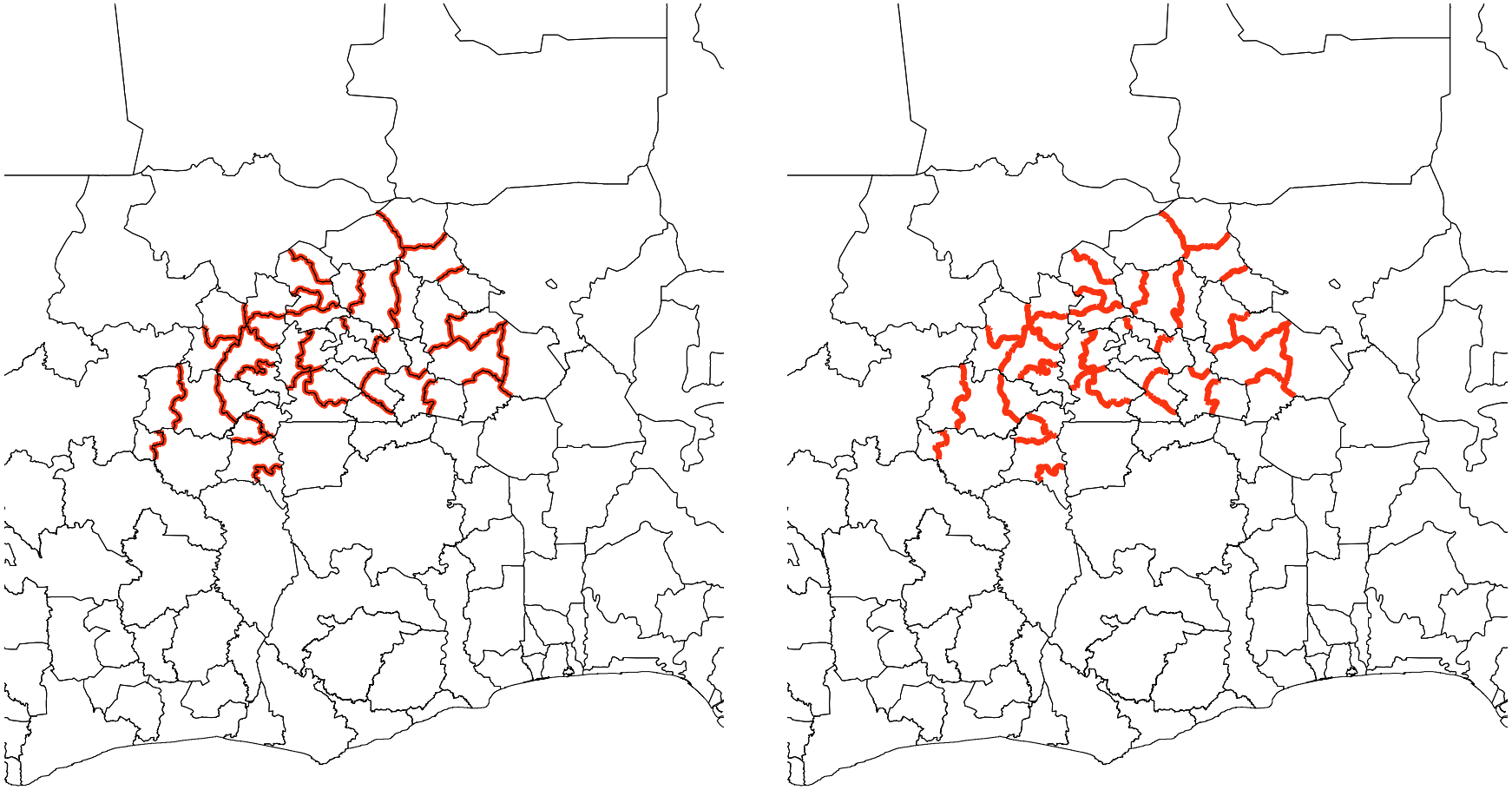
Online Appendix



(a) SUBNATIONAL BORDERS IN 2000

(b) SUBNATIONAL BORDERS IN 2001

Figure A.1: Splits across Africa in 2001. Subfigure (a) shows a map of subnational borders across Western-Africa (in particular Côte d'Ivoire and Liberia; see Table 1) as of 2000. Subfigure (b) shows subnational borders as of 2001. Red lines indicate borders (lines) that emerged between 2001 and 2001.



(a) SUBNATIONAL BORDERS IN 2000

(b) SUBNATIONAL BORDERS IN 2001

Figure A.2: Mergers across Africa in 2001. Subfigure (a) shows a map of subnational borders across Western-Africa (in particular Burkina Faso, see Table 1) as of 2000. Subfigure (b) shows subnational borders as of 2001. Blue lines indicate borders (lines) that vanished between 2000 and 2001.

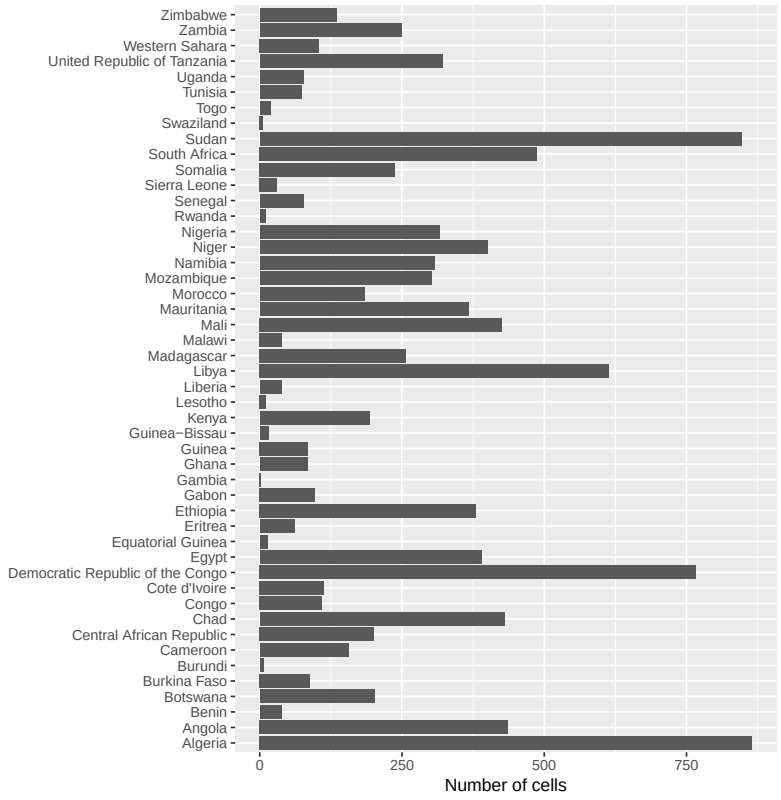
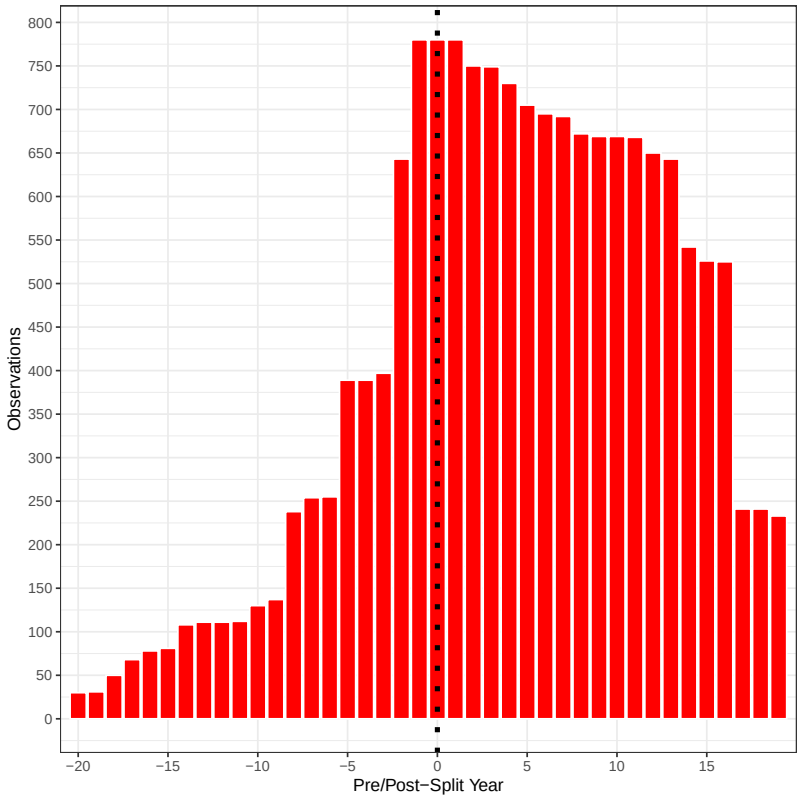
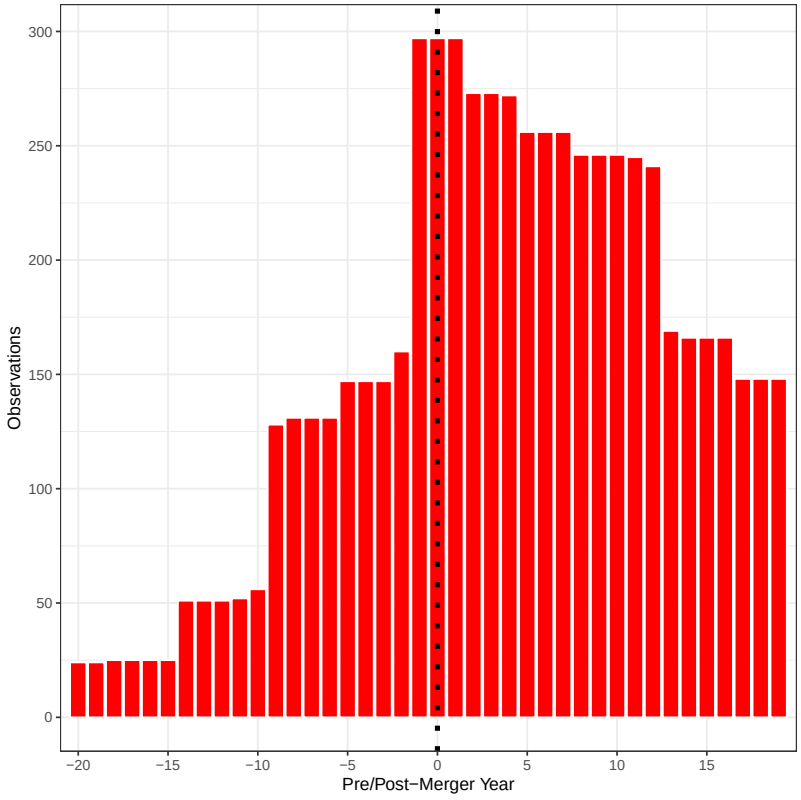


Figure A.3: Total number of cells across countries. This figure shows the total number of cells in each country included in the sample.

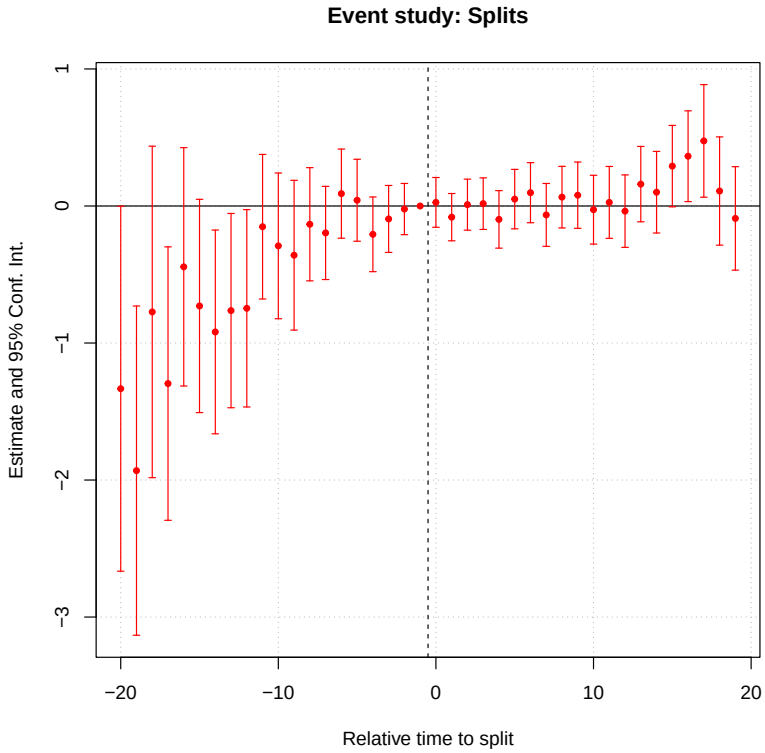


(a) SPLITS

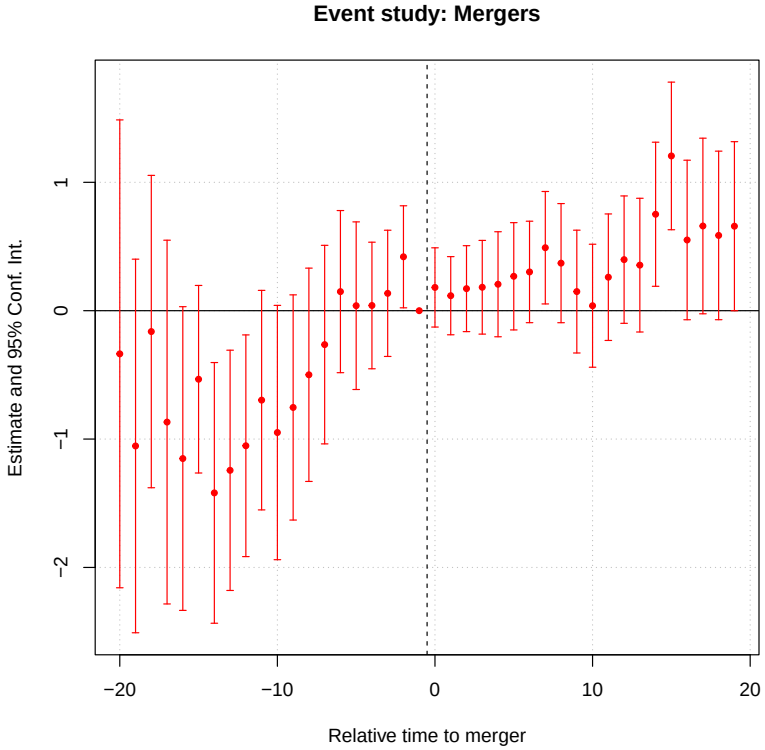


(b) MERGERS

Figure A.4: Number of normalized pre- and post-treatment years for event-study plots on splits and mergers. This figure shows the number of observations available for each (normalized) pre- and post-treatment year for both splits and mergers .



(a) SPLITS



(b) MERGERS

Figure A.5: Traditional event-study plots for splits and mergers. This figure shows event-study plots using traditional difference-in-differences specifications at the cell-level for splits and mergers covering pre- and post-treatment periods. The whiskers indicate the 95% confidence intervals. Standard errors are robust to heteroscedasticity and clustered at the cell-level.

Table A.1: COUNTRY-LEVEL INSTITUTIONAL QUALITY

Variable	Government Effectiveness	Political Violence	Democracy
Algeria	0.246	0.633	-1.273
Angola	0.180	0.637	-2.045
Benin	.	.	6.364
Botswana	0.262	0.841	7.773
Burkina Faso	0.131	0.673	-1.818
Burundi	.	.	2.182
Cameroon	0.196	0.653	-4
Central African Republic	.	.	1.545
Chad	.	.	-2.364
Congo	0.0625	0.676	-2.364
Cote d'Ivoire	0.0971	0.651	.
DRC Congo	0.0249	0.448	2.182
Egypt	0.125	0.828	-4.773
Equatorial Guinea	.	.	-5.909
Eritrea	.	.	-6.619
Ethiopia	0.161	0.588	-0.727
Gabon	0.210	0.732	-2.409
Gambia	0.125	0.799	-4.045
Ghana	0.323	0.726	4.727
Guinea	0.246	0.566	-1.045
Guinea-Bissau	0.176	0.604	3.091
Kenya	0.277	0.642	2.682
Lesotho	.	.	6.409
Liberia	0	0.561	2.591
Libya	0.152	0.766	-6.045
Madagascar	0.131	0.666	6.318
Malawi	0.280	0.703	4.455
Mali	0	0.716	6.364
Mauritania	.	.	-4.409
Morocco	0.261	0.783	-6
Mozambique	0.133	0.756	4
Namibia	0.285	0.844	6
Niger	0.165	0.668	3.955
Nigeria	0.141	0.608	1
Rwanda	.	.	-4.455
Senegal	0.147	0.661	4.409
Sierra Leone	0.00331	0.636	2.364
Somalia	0	0.342	0.476
South Africa	0.289	0.718	8.818
Sudan	0.131	0.457	-5.600
Swaziland	.	.	-9.045
Tanzania	0.0625	0.747	-1.545
Togo	0.0159	0.603	-2.500
Tunisia	0.261	0.841	-2.409
Uganda	0.246	0.610	-2.909
Western Sahara	.	.	.
Zambia	0.131	0.770	4.818
Zimbabwe	0.230	0.673	-3.273

This table collects the average value of the government effectiveness and the political violence and stability scores of the ICRG and the Polity2 Variable from the Polity IV project during the sample period (1992-2013).

Table A.2: BORDER CHANGES AND ECONOMIC DEVELOPMENT IN AFRICA: TRADITIONAL DIFFERENCE-IN-DIFFERENCES RESULTS

	(1)	(2)	(3)
Border Change	0.1105		
	(0.0876)		
Split		0.1137	
		(0.0884)	
Merger			0.3786**
			(0.1873)
Cells	10,667	10,667	10,667
Countries	48	48	48
Observations	231,692	231,692	231,692
R^2	0.882	0.882	0.882
Within R^2	0.000	0.000	0.000

[a] This table collects results from traditional difference-in-difference regressions that relate border changes in Africa to the log of night light output. The units of observation are 0.5×0.5 degree cells. The sample includes all grid-cells covering Africa over the period 1992-2013. Cells covering Ethiopia / Eritrea before 1993 and cells covering Sudan / South Sudan after 2010 are dropped from the sample.

[b] Stars indicate significance levels at 10%(*), 5%(**) and 1%(***).

[c] Heteroscedasticity robust standard errors in parentheses. Standard errors are also clustered at the cell-level.