Legibility and External Investment: An Institutional Natural Experiment in Liberia *

Darin Christensen[†]
Alexandra Hartman[‡]
Cyrus Samii[§]

November 10, 2020

Abstract

We address a debate over the effects of private versus customary property rights on external investment. Despite political economists' claims that external investors favor private property rights, other experts argue that customary systems enable large-scale "land grabs." Our model organizes these competing claims and highlights tradeoffs due to differences in legibility versus the ability to displace land holders under both systems. We study a natural experiment in Liberia where law codifies parallel private and customary property rights systems. We exploit this institutional boundary and difference-in-differences methods to isolate differential changes in external investment under private and customary property rights systems following the Global Food Crisis of 2007–8. We find a larger increase in land clearing where private property rights prevailed related to larger and more active agribusiness concessions. Qualitative study of a palm oil concession reveals the challenges that external investors face navigating customary systems.

Word Count: 11,184

*We thank Gregory Kitt, Horacio Larreguy, and Ben Morse for help securing data. We are also grateful to Peter Rosendorff, David Stasavage, Jessica Steinberg, and Barry Weingast and audiences at EPSA, King's College Political Economy, PIEP, UCL, UCLA's IDSS Workshop, and the World Bank's 2017 Land and Poverty Conference for comments on earlier drafts.

[†]Public Policy and Political Science, UCLA. e: darinc@luskin.ucla.edu
[‡]Political Science and Public Policy, UCL. e: alexandra.hartman@ucl.ac.uk
[§]Politics, NYU. e: cds2083@nyu.edu

1. Introduction

The Global Food Crisis that started in 2007 led to a spike in the demand for land in developing countries. The Land Matrix estimates that agricultural land acquisitions now total over 40 million hectares (an area larger than Germany), and another 20 million hectares are covered by intended deals (Nolte, Chamberlain, and Giger 2016: vi).

These trends have sparked debate about the institutions that attract external investment. Past work argues that foreign investors favor stable democracies that protect private property (Li and Resnick 2003; Jensen 2008). In their recent quantitative synthesis, Li, Owen, and Mitchell (2018) find that stronger property rights mediate the relationship between democracy and foreign investment.[1] This is encoded in international indexes that rate the risk of expropriation (PRS Group) or "business freedom" (Heritage Foundation) afforded by different states (see Pandya 2016 for a recent systematic review of FDI determinants). Yet, Deininger and Byerlee (2011), echoing the concerns of many stakeholders in developing states, claim that the recent spate of deals—sometimes termed "land grabs"—follows a different logic. Investors focus attention on countries like Liberia, where they can negotiate with customary or government authorities to displace prior land holders and acquire large tracts at low prices (see also Wily 2011).[2] In this account, private property deters land investments, which get bogged down by protections that require, for example, consent from, and compensation to, existing land holders.

This debate in international political economy echoes a disagreement among anthropologists and political scientists about whether customary property rights deter investment. Customary prop-

[1] Notably, Li, Owen, and Mitchell (2018) also find evidence of publication bias in prior observational research on whether and why democracy promotes FDI.

[2] Officials have made similar claims about foreign land acquisitions: João Carrilho in Mozambique's National Directorate of Lands and Forestry observes, "You can give twenty bicycles to a local chief and get a big piece of customary land. This is why we need to [...] see that everyone has a title. That way it will be a lot harder for people to come in and take over their land" (French 2014: 219).

erty rights continue to govern huge swaths of land, covering two thirds of Africa (roughly two billion hectares) (Wily 2012). On the one hand, these customary institutions can be more flexible: customary authorities can reallocate land without fearing legal challenges from individual property owners (Lawry 2012). By this same logic, unconstrained customary authorities can displace local land holders to free up tracts for new commercial investment (Kabia 2014). In case studies of 38 agribusiness investments across four African states, Schoneveld (2017: 125) finds that local chiefs enable external investment, alienating land without consulting constituents, often in return for substantial cash payments or gifts. On the other hand, customary tenure can be difficult for outsiders to understand. Scott (1999) argues that these property rights systems are less externally "legible." And where the rules for acquiring land are difficult to discern, external investors incur high transaction costs.

We write a simple model to organize these competing claims. Private property entails individual and transferable titles, while the customary system allows customary authorities to influence the allocation of land. Which system generates more external investment depends on the relative transaction costs (i.e., legibility) and customary authorities' accountability to their constituents. If customary systems generate prohibitive transaction costs, we should expect greater investment under a system of private property. But if customary authorities use their power to displace existing land holders, this could attract investors seeking cheap tracts of land.

We study a natural experiment in the West African state of Liberia—a case frequently used to illustrate both the promise and peril of outside investments in primary commodities. Liberia offers an excellent inferential opportunity because of a unique institutional feature: parallel property rights systems existed in different parts of the country throughout much of its history. In the County Area (also dubbed the Littoral Area), settlers established a formal system of private property. By contrast, Liberian law stipulates that customary property rights govern land in the Hinterland, further than forty miles inland from the coast.

We use panel data to look at whether, as external demand for land increases following the Global Food Crisis, we see differential changes in land clearing (our primary measure of investment) on either side of this institutional boundary. We employ a difference-in-differences estimation strategy to isolate the differential changes generated by the external demand shock.[3] To bolster our empirical strategy, we restrict attention to areas near the institutional boundary with similar pre-crisis trends in land clearing and comparable agro-climatic, demographic, and socio-economic profiles.

In the aftermath of the Global Food Crisis, we find a larger increase in land clearing in the County Area, where private property rights prevail. Customary property regimes are not especially permissive of appropriation by external investors, which is important to document, because it assuages concerns about external investors collaborating with chiefs to execute land grabs. In addition to our main result, we look into mechanisms, focusing on the large increase in concession agreements concluded (largely) by external investors. Agricultural concessions, for which we see the most intense forest clearing activities, are concentrated in the County Area. And restricting attention to these concession areas, we see more land clearing in agricultural concessions in the County Area. Property rights systems appear to affect both the extensive and intensive margins for external investment.

Qualitative analysis provides additional evidence. Studying the case of Golden Veroleum Liberia (GVL), a major palm oil concessionaire, we find that customary systems entail costly negotiations with chiefs, elders, and other local authorities. Initially, these transaction costs were offset by promises to displace land holders. However, external pressure to provide free, prior, and informed consent to prior land holders drove up GVL's costs to using land under customary control. The case suggests that, by drawing attention to land grabbing, activists may have actually confined the practice.

[3] As a robustness check, we implement a regression discontinuity design using cross-sectional data from before and after the Global Food Crisis (see Appendix C.4).

2. Theory: Property Rights Systems and Outside Investment

Past work in international political economy argues that foreign investors favor states that protect private property. Much of this research focuses on the commitment problem facing foreign investors (Frieden 1994). Scholars have emphasized two solutions: democratic institutions that constrain expropriation by host governments (Li and Resnick 2003; Jensen 2008), and international agreements (especially, bilateral investment treaties) that codify dispute-settlement procedures (see Milner 2014; Pandya 2016 for recent reviews). A primary concern in this literature is the obsolescing bargain, in which host countries later revise the terms of investment to capture more value from fixed assets. Our analysis focus on other strategic factors; external investors worry less about an obsolescing bargain in states like Liberia with limited state capacity.[4] Rather, we focus on what we understand to be first-order concerns in such contexts: transaction costs due to legibility and the potential for bottom-up resistance.

With respect to legibility, the current literature devotes less attention to how private property simplifies acquisition by outsiders.[5] Scott (1999: 45) argues:

> "For purely local purposes, a cadastral map [of land parcels] was redundant. Everyone knew who held, say, the meadow by the river, the value of the fodder it yielded, and the feudal dues it carried; there was no need to know its precise dimensions [...] But a proper map seems to have come into use especially when a brisk market in land developed."

The delineation of land titles allows external investors (or, historically, settlers) to acquire a land parcel without first needing to understand the local property regime. "[T]he imposition of free-hold property was clarifying not so much for the local inhabitants—the customary structure of rights had

[4]The history of Firestone in Liberia reflects this (Rosenau et al.: 17–23).
[5]Like Scott (1999) we adopt an encompassing definition of external investors, which includes foreign and also domestic actors who are unfamiliar with the local property rights regime.

always been clear enough to them—as it was for the tax official and land speculator" (39). Private property rights, thus, facilitate land acquisition and investment by lowering transaction costs for external investors.

These arguments contrast with the narrative around "land grabbing," which increased in salience with the onset of the Global Food Crisis in 2007. Food prices ticked up in the early 2000s and spiked in 2008 (Cotula 2012: 662). The prices for palm oil and rubber, the two commodities most commonly produced on Liberia's agricultural concessions, track broader food indexes (see Appendix Figure A.3).[6] Longer-run projections suggest that commodity prices will remain high. This (projected) rise in prices prompted a global search for arable land. Deininger (2011: 217) observes that the Global Food Crisis led to a huge spike in land demand, particularly in Africa, "where two-thirds of such demand is concentrated and where demand in 2009 alone was equivalent to more than 20 years of previous land expansion." According to the Land Matrix's database, between 2000 and 2006, 91 deals had been implemented across Africa; by 2014 that number increased to 791 (see Appendix Figure A.4).[7]

Liberia became a target for these new land investments. A 2012 report offers a startling assessment: "75 percent of Liberian land is already committed, at least theoretically" (De Wit 2012: 1). Deininger and Byerlee (2011: 55) argue that international investors increasingly favor states like Liberia, because they have weak property rights and land can be acquired "essentially for free and in neglect of local rights." Kabia (2014: 719) explains how customary authority can be wielded to enable this land grabbing:

> "A chief can also take arable land away from a subject due to neglect and or non-utilization [...] The chief's power in this instance is unchecked, resulting in a unilat-

[6]Commodity price increases coincide with Ellen Johnson Sirleaf's election as President of Liberia in 2005. Her good standing internationally may have amplified the demand shock from the Global Food Crisis.

[7]This has been observed elsewhere: Albertus (2019) finds that rising commodity prices increased conversions of public land in Colombia to private holdings in areas well-suited for coffee growing.

eral decision to divest land. In that way, the chief's discretion under African customary law can become a pretext for land transactions that exclude the local people's input."

In these accounts, outside investors gravitate to customary systems where authorities can facilitate large-scale transfers.[8] In practice customary property regimes (even when incorporated into pluralistic property rights systems) may privilege elites with control over land rather than land users (Boone 2014; Wily 2012).

We construct a model that incorporates these competing claims. On the one hand, outside investors may favor systems with private property rights, where they can directly negotiate with land holders. On the other hand, if local authorities can displace local land holders and, thus, depress prices, this could attract investors. The balance of these forces then determines whether more or less external investment occurs in areas governed by different property rights systems.

2.1 Investment under Private Property

We start with a simple model of external land investment (see left side of Appendix Figure A.1). An external investor (I) approaches land holders (F) and proposes to lease an amount of land ($\ell \geq 0$) at a unit price ($p \geq 0$). Investors maximize profits given by $\pi(\ell, p, t_{pp}) = (k/a)\ell^a - \ell(p + t_{pp})$, which incorporates transaction costs ($t_{pp} \geq 0$) and diminishing marginal returns ($k > 0$; $a = 1/2$). While we treat land holders as a unitary actor, we do incorporate transaction costs and permit these to vary under private property and the customary system described below. These transaction costs capture, for example, the challenges associated with coordinating purchases across land owners.[9]

[8] Chiefs can play different roles: Baldwin (2013: 798) argues that chiefs in Zambia catalyze local service provision; in other contexts the relationship may be more extractive.

[9] We do not include the central government as a separate actor; all large-scale land leases for agriculture, mining, or forestry in Liberia are codified in concession agreements—contractual arrangements in which the central Government of Liberia grants land for commercial development. External investors in Liberia thus enjoy the same legal protections throughout the country, in both

The land holders can reject this offer, end the game, and earn the prevailing rental rate ($r > 0$). In that case, the investor pays and earns nothing.

In equilibrium, the investor offers the lowest price that leaves the land holders indifferent between accepting and rejecting: $p^* = r$. Given that price, the investor maximizes profits by leasing $\ell^*_{pp} = [k/(r+t_{pp})]^2$. Unsurprisingly, land acquisition falls as price increases, either due to higher transaction costs or an increased rental rate.

We do not separate the investor's decisions about, first, how much land to acquire and, second, what of that acreage to clear and cultivate. In addition to simplifying the exposition, our case study suggests that similar factors affect both choices.

2.2 Investment under Customary System

In the customary system, a local leader assumes a role in negotiations with outside investors (Logan 2013: 354). For shorthand, we refer to this person as the chief (C); in practice, this could be one or more elites that negotiate on the community's behalf. We amend our model to incorporate this third actor (see right side of Appendix Figure A.1). In this new game, the chief accepts or rejects the investor's proposed price and lease area $\{p, \ell\}$. If they reject, the game ends with the investor paying and earning nothing, the land holder earning the rental rate ($r\ell$), and the chief collecting a tribute from the land holders of $\tau\, r\ell$ where $\tau \in (0,1)$. If the chief accepts, they choose a proportion of the lease payment ($e \in [0,1]$) to keep for themselves ("to eat") and pass along the remainder to the land holders.

The land holders can accept that share, ending the game with the investor earning $\pi(\ell, p, t_c)$; the land holder, $(1-e)\; p\ell$; and the chief, $e\; p\ell$. ($t_c > 0$ are transaction costs in the customary area.) Alternatively, the land holders can contest the chief's allocation. With probability $q \in (0,1)$, the

the County and Hinterland areas. Nonetheless, any differences in the way the central government operates across these two areas would be captured in the transaction costs term.

chief withstands this challenge and pockets all of the lease payment; otherwise, with complementary probability, the land holders succeed in their challenge, and the investment is cancelled.[10] In the latter case the land holders earn the rental rate for their land; the investor earns and pays nothing; and the chief is punished at a cost $c > 0$, which is scaled by ℓ. q in this model captures accountability, whether the chief can flout their constituents and withstand the consequent challenge.

Working backwards, the land holder accepts the chief's allocation iff $e \leq \bar{e}$, where $\bar{e} = 1 - [(1-q)r]/p]$. There is a level of rent-seeking (above $\bar{e}$) that the land holder simply cannot abide. Knowing this, the chief either completely shuts out the land holders, choosing $e^* = 1$ and provoking a challenge, or chooses the largest amount of rent-seeking that the land holders tolerate $e^* = \bar{e}$. The chief opts for the latter iff $p \geq r - c$. To simplify, we reasonably assume that $c \geq r$, such that this condition always holds. Given what they can eat from the lease payment, the chief has to decide whether to agree to the investor's terms, accepting iff $p \geq \underline{p}$, where $\underline{p} = r[\tau + (1-q)]$. Finally, the investor offers the lowest price that leaves the chief indifferent between accepting and rejecting, $p^* = \underline{p}$. The investor maximizes profits by leasing $\ell_c^* = [k/(\underline{p} + t_c)]^2$.

2.3 Investment under Different Property Rights Systems

We can now compare equilibrium investment levels under the two different property rights systems.[11] The model focuses attention on two sources of divergence: transaction costs and the chief's (or other local intermediaries') accountability to their constituents.

[10] The chief's accountability and the tax rate can be positively correlated. We assume $\partial\tau/\partial q < 1$, consistent with work relating effective tax rates to accountability (Besley and Persson 2011).

[11] To illustrate how the models relate, consider the extreme case of the feckless chief that collects no tribute ($\tau = 0$) and is unable to flout their constituents ($q = 0$). This chief accepts an offer of $p = r$ from the investor and passes along all lease payments to the land holder ($\bar{e} = 0$). The equilibrium level of land investment diverges only if transaction costs differ under the two systems.

First, suppose the investor can offer the same price under both systems. Yet, transaction costs differ: for example, due to the illegibility of the customary system. In this case, the investor prefers to acquire more land under a system of private property where the ultimate unit price is lower.

Second, to see the role of accountability, suppose that transaction costs are the same across the two systems ($t_c = t_{pp}$). Investors will acquire more land under a system of private property if they can lease at a lower price: when $q < \tau$. This condition *fails* where constituents struggle to challenge the chief's authority. Where chiefs are unaccountable, they can completely shut out the land holders, eating the entirety of the lease payment. As the the chief's cut of the lease payment grows, the price they demand from the investor falls. Put simply, when the chief does not have to share, they are satisfied with a lower price. In practice, this looks like displacement or "land grabbing"—existing land holders forced to give up their land to outside investors with little compensation while local authorities continue to pocket rents.[12]

Combining these two dynamics, investment will be greater under the private property rights system iff:

$$t_c - t_{pp} > r(q - \tau) \tag{1}$$

Intuitively, the amount of land leased depends on the ultimate price (including transaction costs), which will be higher under the private property system where the chief is accountable (low q) and transaction costs associated with the customary system are greater ($t_c > t_{pp}$).

This model helps organize conflicting predictions regarding the relationship between property rights systems and investment levels. Deininger and Byerlee (2011) claim that investors target areas where they can acquire land at next to nothing by neglecting local rights. These correspond

[12] Acemoglu, Reed, and Robinson (2014: 355) find in neighboring Sierra Leone that less accountable chiefs exercise greater control over how their constituents use and transfer land.

to places where constituents have little hope of successfully contesting concession agreements negotiated on their behalf (q is large).

Yet, transaction costs are often higher where land holders do not hold titles to their land. Rather than transacting directly, customary systems require investors to negotiate with local authorities. These negotiations occur in contexts where highly localized use and transfer rights remain murky (sometimes contested), and formal policies or legal institutions do not have the legitimacy required to adjudicate boundary disputes or clarify investors' obligations and protections.

Much of the debate around land grabs—and our own empirical strategy—focuses on changes in investment driven by external demand, particularly rising global food prices. In our model, this price change can be mapped to an increase in k, which scales the value of land for the external investor. The question then is whether investment increases more sharply under a system of private property as k rises (i.e., $\partial \ell^*_{pp}/\partial k - \partial \ell^*_c/\partial k > 0$)? So long as equation (1) holds, this difference in differences will be positive.

3. Background: Land Administration and Investment in Liberia

Liberia provides an opportunity to evaluate the model's predictions: parallel property rights regimes existed throughout much of its history. In the County Area, settlers established a formal system of private property. By contrast, Liberian law stipulates that customary property rights govern land in the Hinterland, beyond 40 miles from the coast.

3.1 Parallel Property Rights Systems

Liberian law divides the country into two zones:

> "The territory of the Republic shall be divided for the purpose of administration into the County Area and Hinterland. **The County Area shall include all territory extending from the seaboard forty miles inland and from the Mano to the Cavalla Rivers.' The Hinterland shall commence at the eastern boundary of the County Area; i.e., forty miles inland and extend eastward as far as the recognized limit of the Republic**" (Government of Liberia 1956 emphasis added)

These zones demarcated two systems of property rights: in the County Area, Americo-Liberian settlers and their descendants instituted a "Western statutory system of land ownership based on individual fee simple titles" (USAID 2016). Fee simple titles are the highest possible ownership interest under common law; holders can alienate, divide, or hand down their property. In the Hinterland (roughly 60 percent of Liberia's territory), customary authorities (a hierarchy of chiefs and other elders) govern communal land; individuals or families living in these areas enjoy access rights that fall short of full ownership.

Figure 1 displays the institutional boundary (dashed) forty miles from the coast, as well as the inland extent of land purchases by early settlers as of 1853. This correspondence reflects what Unruh (2008: 20) calls "discriminatory pluralism," the early practice of granting private, fee-simple titles to settlers while denying those same rights to "indigenous" populations unless they became "civilized." This was never a sharp institutional discontinuity: some indigenous communities in the County Area continue to hold land under customary tenure (Lawry 2012: 9). Historical accounts do not explain why settlement did not extend beyond 40 miles; Christy (1931: 523) writes only "it was plain that the Constitution could not operate beyond that limit." The boundary does not clearly demarcate physiographic zones: both sides feature rolling hills and plateaus and (prior to more recent forest clearing) dense, well-watered forests (Christy 1931).

As is apparent in Figure 1, the 40-mile institutional boundary and early land purchases diverge in Liberia's Southeast (shaded in gray). The 40-mile boundary is less salient in these southern

Figure 1: Boundary between in Liberia's Property Rights Systems

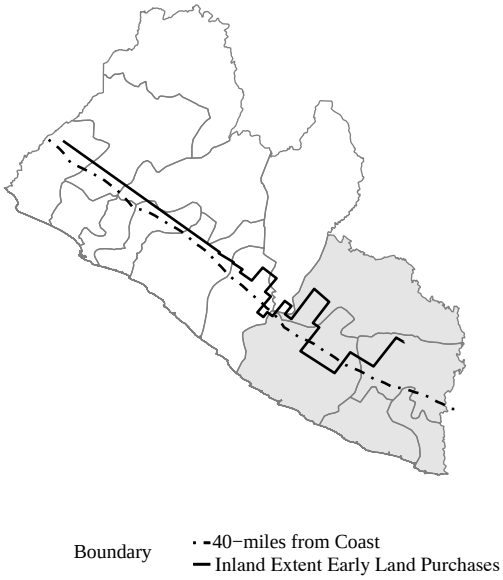


Figure 1: the institutional boundary 40 miles inland (dashed) and land purchase boundaries of settlers (solid) diverge in the shaded counties. We designate these—Grand Gedeh, Grand Kru, Maryland, Sinoe, and River Gee—the "southern counties" and exclude them from selected analysis.

counties: both the settlers and the extent of inland settlement differed in the Southeast and, thus, the 40-mile boundary there does not overlap with the historic titling that established private property rights in the County Area (see Appendix C.4).

3.2 Property Rights Systems and Land Investment

The Hinterland has customary property rights that are not easily discerned by external investors. First, little or no formal documentation of land holdings exists (Stevens 2014). The Government of Liberia has never conducted a general survey of land in the Hinterland. Instead, community members rely on natural landmarks and oral histories to identify the boundaries of their landholdings (Wily 2007). A 2015 World Bank report observes that external investors in Liberia's hinterland must sort out vague, overlapping claims to land, and "local systems for managing these claims—

generally a standard hierarchy of customary authorities—are not equipped to manage these conflicts in concession areas" (World Bank et al. 2015, 29). This is not unique to Liberia; Scott (1999: 37–9) refers to this as the "illegibility of communal tenure."

Second, the legal status of land was not defined until the 2017 Land Rights Act. For most of the 20th Century, Liberian law suggested that all land in the Hinterland should be considered public land, with allocative authority resting with the central government (Bruce 2008). Although some property rights legislation suggested that local authorities retain decision-making power over community land,[13] it did not practically distinguish between community and public land.

Third, community lands cannot be alienated or used as collateral without permission from customary authorities. Any proposed sale of community lands necessitates an impracticable process of acquiring a tribal certificate.[14] Even land held by families (separately from community land) cannot be transacted without permission of the authorities and elders who claim indigenous status in the community (Wily 2007).

The customary system thus requires investors to unravel local property claims and negotiate with customary authorities. This could raise transaction costs, but also permits land deals that could not be concluded under a system of private property. Without title or even clear legal status, previous land holders can be displaced from their plots without consent; absent a functioning land market, prices can be set (artificially low) by local authorities. The World Bank summarizes: "communities and individuals in concession areas [often] lack formal ownership rights under the current law, despite the fact that they have long inhabited or productively used the land . . . Concessionaires have generally been left to develop their own policies with regard to these claims" (World Bank et al. 2015, 29).

[13] For example, between 1923 and 1956, the Hinterland Laws permitted communities in the Hinterland to own land communally, but these rights were abolished in 1956 with the passage of the Aborigines Land Law, which accorded only usufruct rights to hinterland communities.

[14] A tribal certificate required both a survey order from the President of Liberia and then the President's signature on the deed (Stevens 2014).

In contrast, land administration in the County Area has always been much clearer to outsiders. First, land deeds and maps (though poorly organized) exist that identify owners of specific plots. Second, the status of land is defined, with a large proportion of land held by private individuals. Finally, a legal land market exists, with a bureaucracy that supports the process of transferring title (Bruce 2008). The World Bank report cited above outlines the simpler process for external investors acquiring privately owned land in Liberia: "the concessionaire generally negotiates directly with the owner to lease the land and provide annual lease payments" (28).

External investors in Liberia must weigh the illegibility of the customary system against the cost-savings that may be offered by customary authorities. To determine which of these forces prevails, we turn now to the data on investment under Liberia's customary and private property rights systems.

4. Empirical Strategy: Difference-in-Differences around an External Demand Shock

Our interest in external investment focuses our attention on the demand shock induced by the Global Food Crisis of 2007–8; we opt for a difference-in-differences approach, which estimates differential changes in investment during this period of increased external demand. By contrast, baseline differences in investment under the two property rights systems—for example, due to geographic or historical features of the County Area and Hinterland—cannot be entirely attributed to the external demand shock. Our difference-in-differences strategy does not leverage such level differences and, thus, seems better suited to our substantive interest than a regression discontinuity with cross-sectional (endline) data (see Card and Krueger 2000 for an early implementation of a

cross-border difference-in-differences). Specifically, we estimate:

$$y_{it} = \alpha_i + \gamma_t + \beta D_{it} + \eta X_{it} + \varepsilon_{it} \tag{2}$$

where i indexes the 1-km^2 grid cells that serve as our cross-sectional unit; t, year; and D_{it} is an indicator variable that takes a one in the County Area after 2007. X_{it} is a matrix of time-varying covariates. We also report specifications that substitute the year fixed effects for county-by-year fixed effects. (Figure 1 maps county boundaries.)

The difference-in-differences estimation strategy rests on a parallel-trends assumption—namely, that investment would have followed the same trend had there been no difference in the property rights systems. While untestable, we bolster the credibility of this assumption in three ways. First, we focus on a relatively narrow bandwidth around the 40-mile boundary that divides the two property rights systems.[15] In Appendixes C.11, C.12, and C.8 we show that similar agro-climatic conditions, ethnic compositions, and socio-economic characteristics exist within our bandwidth on either side of the institutional boundary. As such, we expect that trends on the Hinterland-side of the boundary provide a credible estimate of counterfactual land clearing or concession activity on the County-side. We also implement a regression discontinuity (RD) design with data from before and after the Global Food Crisis, using an optimal bandwidth of just 7 kilometers and distance to the institutional boundary as the forcing variable. Our RD coefficients generate the same conclusion but are larger in magnitude than our difference-in-differences estimates (Appendix Table A.4), as the RD results reflect cumulative changes in 2014 and include (insignificant) level differences not attributable to the demand shock (see Appendix C.4).

[15] Following Cattaneo, Frandsen, and Titiunik (2015), we find the 40-km bandwidth optimizes with respect to the bias-variance tradeoff, choosing a distance from the cutoff that maintains balance in pre-treatment trends while also allowing for reasonably precise estimation (see Appendix Figure A.6).

Second, readers may still be concerned about slight imbalance even within this narrow bandwidth. Any time-invariant differences, for example in growing conditions or past conflict exposure, will be absorbed by our unit fixed effects (the α_is) and not confound our analysis. Yet, as international demand spikes, investors might also be attracted to the County Area due to residual differences unrelated to the property rights systems. To alleviate concerns about time-varying confounds, we show in Appendix Tables A.7 and A.9 that interacting static differences in demographics, conflict exposure, or market access with an indicator for the period after the Global Food Crisis does not meaningfully affect our estimates.[16]

Finally, we show both in the raw data (Figure 3) and in the placebo tests reported in Appendix Figure A.6, that investment on either side of the boundary follows similar trends prior to the Global Food Crisis. The absence of differential pre-trends in our outcome variable increases confidence that trends across the boundary would have remained parallel in the absence of the external demand shock.

We take two approaches to constructing our standard errors. First, we cluster on district. This allows for serial correlation across the entire study period, but assumes that administrative boundaries delimit spatial auto-correlation. Second, following Conley (1999), we allow for serial correlation, as well as spatial auto-correlation among cells that fall within a certain distance of each other.[17] We find that clustering on district tends to be more conservative than Conley's spatial heteroscedasticity and auto-correlation consistent (spatial HAC) estimates. While nominally we have over two million grid cells, these clustering approaches account for the possibility that out-

[16]Electoral support for President Sirleaf does not split along the institutional boundary. Rather, her opponent in the 2005 election, George Weah, drew his support from the southern counties (particularly Grand Gedeh, Grand Kru, Sinoe, and River Gee). We drop these counties in models 2 and 4.

[17]The code we use to compute Conley's standard errors does not currently permit the inclusion of unit-by-year fixed effects.

comes in adjacent cells are highly correlated and ensure that we do not underestimate our level of uncertainty.

5. Data

5.1 Forest Loss

Our main outcome data come from Hansen et al. (2013), whose method for estimating deforestation now provides information on annual forest cover loss from 2000–2014 at a high spatial resolution (30 meters at the equator). Over 50 million cells are contained in our 40-kilometer bandwidth around the discontinuity. We aggregate these 30-m cells to a roughly 1-km resolution by creating blocks (36×36) of the original cells. Forest loss represents the complete removal of the tree cover canopy according to Landsat satellite imagery. Our dependent variable (y_{it}) measures the proportion of cell i that experienced forest loss in or before year t.

Forest loss provides a good measure of land conversion in Liberia. First, Hansen et al. (2013: 853) argue that these data can be used to better understand "the economic drivers of natural forest conversion to more intensive land uses," and a number of studies have employed the measure to study concession activity in other contexts (e.g., Abood et al. 2015; Gaveau et al. 2016; Ali, Deininger, and Harris 2019). Second, as is apparent in Figure 3(b), at the beginning of our time series less than one percent of cells within our 40-kilometer bandwidth had experienced forest loss. We are unlikely to miss changes in land use on already deforested land. Third, forest loss captures investments related to agricultural concessions (e.g., clearing and de-stumping to prepare the land for planting). Wily (2011: 736) notes that agribusiness investors favor intact forests; "only commons provide contiguous and intact estates sought by large-scale investors. Many developers, especially those planning to plan jatropha or oil palm, prefer virgin or forested land." We can also show this empirically by assessing the uptick in forest loss associated with active concessions

agreements (described in detail below). Starting with a simple before-after comparison, in the year before agricultural concessions start forest loss averages just over five percent; by 2014 that rate increases to over fourteen percent. Appendix Table A.1 reports difference-in-difference estimates to account for time-invariant confounders and secular trends in forest loss. These results indicate that forest loss increases dramatically after a cell is incorporated into an agricultural concession.

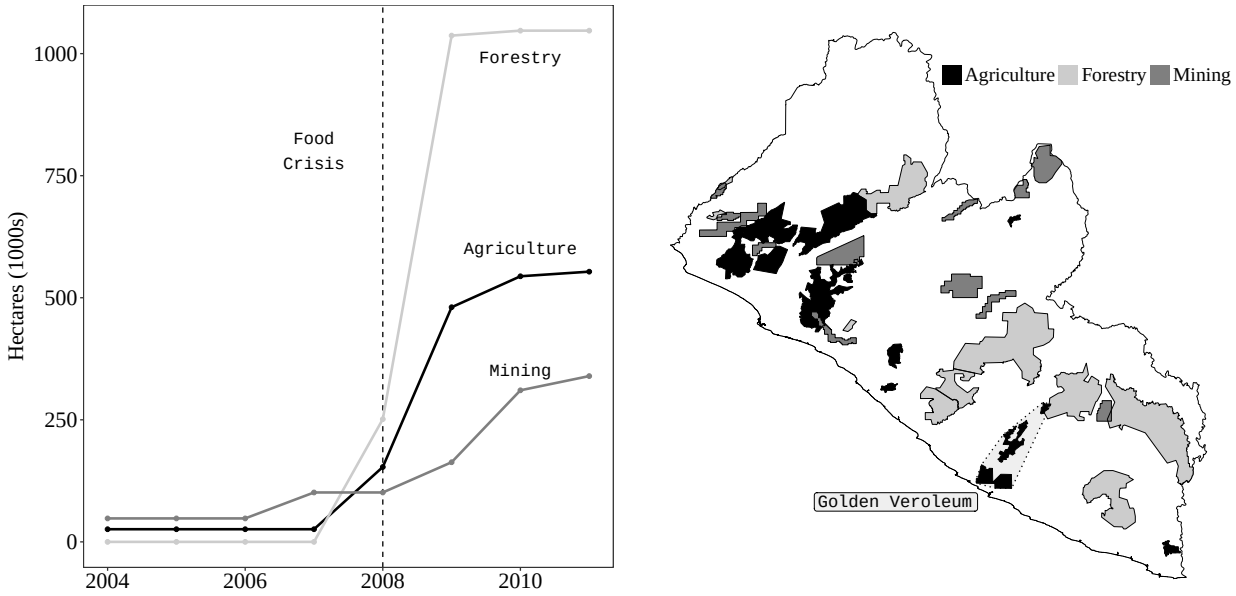
5.2 Concession Areas

To map external investments, we acquired current concession boundaries from Liberia's National Bureau of Concessions in 2016. Concession agreements are contractual arrangements between an investor and the Government of Liberia that grant tracts of land for commercial development. Even if local residents or communities are not legal parties to concession agreements, they negotiate with concessionaires over land use. These data include 25 unique concession holders (excluding community managed forests): 8 in agriculture (totaling 553,400 Ha.), 10 in forestry (1,047,100 Ha.), and 7 in mining (339,500 Ha.).[18] These data include the start date for each concession, which allows us to plot the area held under concession agreements over time. As is apparent in Figure 2, agribusiness activity increases after 2007.[19] This increase mirrors regional and global trends: Appendix Figure A.4 shows a dramatic rise in land investment deals across Africa, Asia, and the Americas in the half decade following the Global Food Crisis.

[18] The small number of concession holders limits our exploration of investor-level heterogeneity. The most expansive dataset of concessions from Bunte et al. (2018) includes investors from 24 different countries, with the US, China, Australia, the UK, and Canada being most frequent; our data from the Bureau of Concessions includes foreign agribusiness investors from the US, Luxembourg, Malaysia, and Singapore.

[19] Figure 2 also shows increases in mining and forestry. The uptick in mining relates to a steady and dramatic increase in mineral prices through most of our study period. The sharp rise in forestry concessions in 2009 results from policy changes that established new permitting categories for timber extraction.

Figure 2: Current Concession Activity in Liberia



(a) Area within Commercial Concessions

(b) Commercial Concession Boundaries

Figure 2(a): area held under different types of concessions agreements between 2004–2012 per data provided by the National Bureau of Concessions. Figure 2(b) map of concessions, with a convex hull around Golden Veroleum's concession (dotted line), the subject of our case study.

These areas reflect the concession boundaries, not the area under production. According to the 2015 World Bank report, some agricultural and forestry concessions have seen little activity due, in part, to the challenges associated with negotiating access rights to land. Hence, we rely more heavily on the forest loss measure, which better captures actual land use.

5.3 Agro-Climatic Conditions

To assess differences in terrain and climate near the institutional boundary, we employ interpolated climate surfaces from Hijmans et al. (2005), who provide gridded data at a 1-km spatial resolution for annual temperature, rainfall, and altitude. These measures are from the Global Historical Climate Change Network Dataset, which has undergone extensive quality control. Appendix Fig-

ure A.12 shows the average differences in these variables (residualized by county) using varying bandwidths around the institutional boundary. Within ten to forty kilometers of the boundary: the average annual temperature is identical, average altitude differs by less than 100 meters, and annual precipitation differs by less than 50 centimeters. While this difference in precipitation might be relevant in drier climates, both sides of the boundary receive over 260 centimeters of rainfall annually. At such high levels, estimates from Guan et al. (2015) suggest that 20 percent shifts in total annual rainfall have little effect on crop yields in West Africa. Using the Harmonized World Soil Database (HWSD), we also look at soil qualities, finding no difference in nutrient availability or retention capacity, the latter being "of special relevance for intermediate and high input level cropping conditions."[20]

5.4 Survey Measures

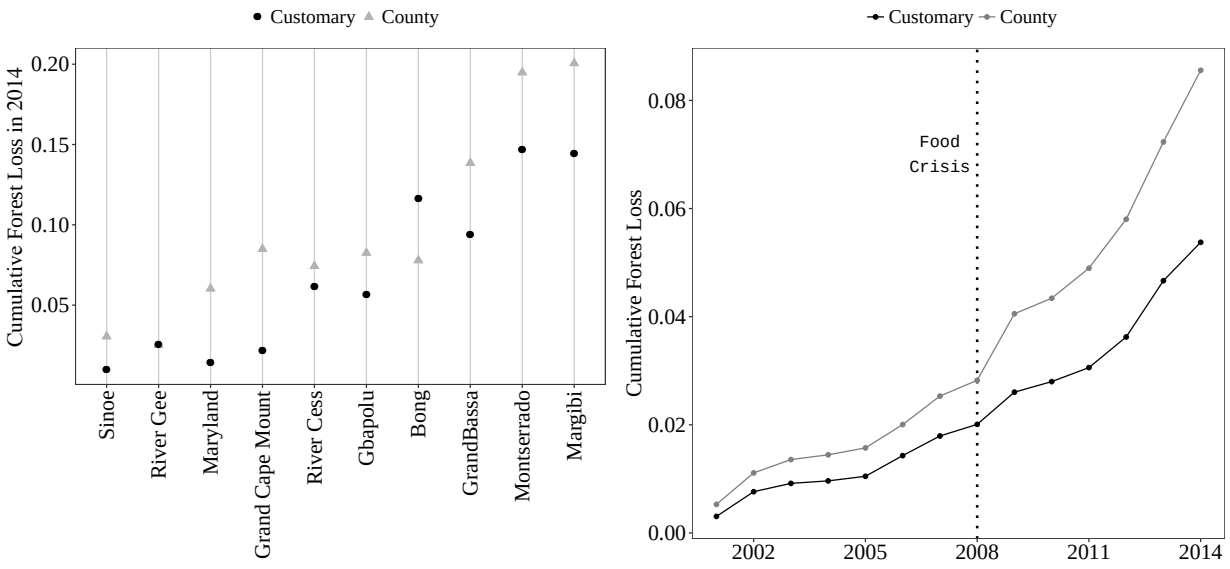
We employ two sets of survey data: the 2008 Liberia National Population and Housing Census; and rounds 4, 5, and 6 of the Afrobarometer survey. We merge the census data, which contain variables on conflict exposure, education, and wealth in over 13,000 geo-coded localities, with our gridded forest-loss data (see Appendix C.8).

6. Results

Our main findings are apparent in the descriptive statistics. We restrict attention to areas that fall within 40 kilometers (or 25 miles) of the institutional boundary and first look within counties bisected by the boundary. With one exception (Bong), Figure 3(a) shows that by 2014 less forest land has been cleared on the customary side. Within the same county and our relatively narrow band around the boundary, we see more forest loss where private property rights prevail.

[20]HWSD Codebook (link).

Figure 3: Cumulative Forest Loss by County and Year using 40km Bandwidth



(a) Cumulative Forest Loss in 2014 by County

(b) Cumulative Forest Loss, 2001–2014

Figure 3(a): in all but one county, a larger proportion of forest has been cleared on the County side of the boundary. Figure 3(b): cumulative forest loss, showing parallel trends up to 2008 and then a differential increase on the County side after the Global Food Crisis. Both figures restrict attention to areas that fall within 40 kilometers (25 miles) of the institutional boundary.

Second, in Figure 3(b) we plot cumulative forest loss on either side of the institutional boundary. While levels of clearing activity were slightly lower in the Hinterland, we see parallel trends in forest loss until 2007. However, after 2008, clearing activity picks up more sharply in the County Area. While cumulative forest loss increases by roughly five percentage points in the County Area between 2008 and 2014, it only increases by only three points in the Hinterland.

Table 1 presents our difference-in-difference estimates from equation (2). (Note that the cell and year or county-year fixed effects absorb $\mathbb{1}$(County) and Post-2007.) These models include a fixed effect for every (1km^2) cell, absorbing all time-invariant characteristics that affect whether an area is cleared (e.g., distance to the coast or capital, soil suitability, elevation, historic settlement patterns, etc.). Moreover, we include year or county-year fixed effects. The latter allow for

Table 1: Differential Change in Forest Loss Following Food Crisis

	Dependent variable:			
	Cumulative Forest Loss			
	(1)	(2)	(3)	(4)
$\mathbb{1}$(County) $\times$ Post-2007 (D_{it})	0.015	0.022	0.013	0.017
Clustered on District	$(0.005)^{**}$	$(0.007)^{**}$	$(0.004)^{**}$	$(0.005)^{**}$
Spatial HAC (10 year, 50 km)	$(0.003)^{**}$	$(0.003)^{**}$		
Mean(y_{it})	0.029	0.04	0.029	0.04
Drop Southern Counties		✓		✓
Cell FEs	148,544	89,654	148,544	89,654
Year FEs	14	14		
County-Year FEs			196	126
Observations	2,079,616	1,255,156	2,079,616	1,255,156

Table 1: linear models per equation (2). All models include cell and year or county-year fixed effects, which absorb $\mathbb{1}$(County) and Post-2007. The sample is limited to cells within 40 km of the institutional boundary, and the unit of observation is a 1km^2 cell observed in each year. The dependent variable is the proportion of each cell that has experienced forest loss. In models (2) and (4), we drop the southern counties (see Figure 1). Significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

non-parametric time trends in each county, picking up temporal variation in weather or local governance that could affect investment decisions. Finally, in models (2) and (4), we drop the southern counties (discussed above). As expected, our estimates increase in magnitude when we exclude the Southeast where the 40-mile institutional boundary does not map onto a historic divide between the private property and customary systems. Our results are robust to using a narrower bandwidths of 30 or even 20 kilometers when we use Conley's standard errors for inference (see Appendix Table A.6).

We find that land clearing increased more dramatically where private property rights prevailed. Our results imply that annual forest clearing increases by around 1.5 percentage points—an effect equivalent to roughly half of the mean of the dependent variable. As an alternative benchmark, it took roughly four years after the end of the Liberian Civil War for cumulative forest loss to increase by two percentage points on either side of the boundary.

6.1 Alternative Explanations

We conduct two falsification exercises. First, to demonstrate that the divergence reported in Table 1 is due to the external demand shock and not differential trends prior to the Global Food Crisis, we code a series of "placebo" crises using the years prior to 2008. Appendix Figure A.6 reports null effects for these placebo crises.

Second, we also look for differential changes around placebo boundaries—fake boundaries twenty or sixty miles from the coast that do not correspond to real institutional differences (see Appendix Figure A.7). In Appendix Figure A.8, we show that forest loss does not differentially increase after the Food Crisis on the coastal side of these placebo boundaries.

Our research design rules out many sources of confounding. The cell fixed effects absorb all time-invariant features that might affect land clearing, such as a soil quality, past conflict, or proximity to the coast. Moreover, by looking only at a band around the institutional boundary, we minimize differences in agro-climatic, conflict, demographic, or market access variables.[21] Any remaining variation along these dimensions only confounds our analysis if it also moderates the post-2007 demand shock. As a check, we interact the available census variables with an indicator for the post-2007 period. Despite losing nearly half of our sample in the merge, our estimates remain significant and of similar magnitude (see Appendix Tables A.7 and A.8). Similarly, road density, distance to Monrovia, or the average distance to ports are not driving the differential increase we observe in the County Area following the demand shock (see Appendix Table A.9).

Finally, the year fixed effects absorb country-wide shocks, such as the global recession, 2011 general election, or ubiquitous policy reforms. We also include county-year fixed effects—flexible

[21] We find no significant difference in wealth across the institutional boundary (see Appendix Figure A.10). Data specifically on land holdings do not exist; however, the sizes of households' plots are less relevant to external investment in the customary area, where the chief can alienate large, multi-plot tracts.

time-trends for each of Liberia's 15 counties. With county-year fixed effects, confounds would have to come from unobserved, time-varying features at the sub-county level. One such confound could be a land or forestry reform implemented around the same time as the Global Food Crisis that boosts clearing and investment in the County Area relative to the Hinterland. Two common features of land and forestry reforms make this an implausible alternative. First, implementation of such reforms has been halting. To take the most prominent example, the Legislature established a Land Commission in 2009 to review and reform land policy. The new Land Rights Act was not passed until 2018, four years after our study period. Second, the reforms that have passed (e.g., the 2009 Community Rights Act) have attempted to rationalize the customary system, minimizing differences between the customary and private property rights systems (Knight et al. 2012: 54–55). If anything, we would expect such reforms to attenuate the differences we find.

6.2 Mechanisms

Our model would have us attribute these differential changes in land clearing to external investments following the Global Food Crisis. Yet, we recognize that local consumption can also contribute to forest loss. The difference-in-differences strategy helps to isolate the global demand effect: our estimates are net of other drivers of forest loss that either do not vary during our study period (e.g., local tree varieties) or uniformly affect all parts of a county (e.g., timber prices). We can marshal more direct evidence that the increase in land clearing is attributable to external investment by looking at the scale of agricultural concessions (the extensive margin) and the rates of clearing within those concessions (the intensive margin).

First, we look at the likelihood that a cell falls within an agricultural concession. Cross-sectional data from 2014 suggests that cells in the County Area (still within 40 km of the institutional boundary) are twice as likely to fall in an agricultural concession: 10 percent under the customary systems in the Hinterland and 20 percent in the County Area (see Appendix Table A.2

model 2). Estimating equation (2), we find that the probability of falling within an agricultural concession increased more dramatically in the County Area after the Global Food Crisis (see models 3–6).

Not only was more land acquired for agricultural concessions in the County Area, but, on the intensive margin, we find more rapid clearing within agricultural concessions in the County Area.[22] Again, we start in Appendix Table A.3 by analyzing the cross-section in 2014, the final year in our data. In the Hinterland, cumulative forest loss in agricultural concessions was about 9 percent; within concessions in the County Area, total loss amounted to around 17 percent. Models 4–7 report estimates from equation (3) (see Appendix C.3). While concession activity leads to higher rates of land clearing under both property rights systems, this effect is more than twice as large in the County Area. Taken together, we find that the area acquired for export-oriented agribusiness and the rate of clearing within agricultural concessions were both greater where private property rights prevail.

Why does external investment concentrate in the County Area? Most fundamentally, we argue that there are different mechanisms for allocating land. In the Hinterland, customary leaders and elders within communities exercise greater control. By contrast, in the County Area, where private property enables individual land sales, prices shape the distribution of land. While these differences may exist in law and theory, past work in West Africa finds that these *de jure* differences in property rights do not always affect investment, because they do not translate into different beliefs and practices (Bubb 2015).

Using geo-coded, individual survey data, we can validate that individuals hold different views about how land should be allocated across the institutional boundary. Round 4 of the Afrobarometer in Liberia includes a set of questions related to customary (i.e., traditional) authorities and

[22] Export data are not available by firm or even sub-nationally; hence, our focus on clearing as a measure of firms' activity.

the administration of land (Appendix Section C.10 lists the questions). We restrict the sample to enumeration areas within 40 kilometers of the institutional boundary and exclude the southern counties. In Figure 4, we plot the differences in the proportion of respondents that agree with statements about traditional leadership and land in the County Area relative to the Hinterland.

Figure 4: Differences in Attitudes Toward Customary Authority and Land

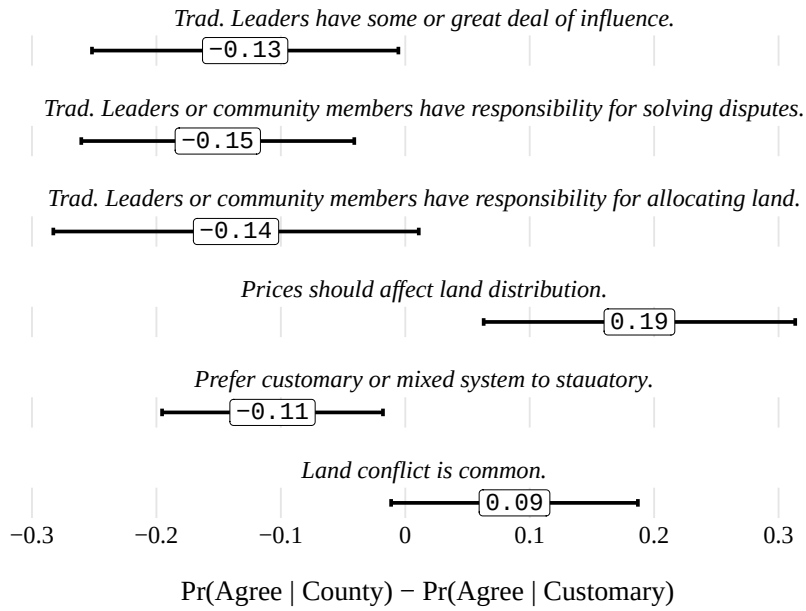


Figure 4: difference in proportion of respondents agreeing in County Area vs. Hinterland (see Appendix C.10). The sample excludes enumeration areas in the southern counties (see Figure 1). The plot displays 90% confidence intervals; standard errors are clustered on enumeration area.

As expected, we find that respondents in the County Area are less likely to feel that traditional leaders or community members should have responsibility for allocating land (a difference of 14 percentage points); they are, however, more inclined to believe prices should affect how land is distributed (by 19 percentage points).[23] Overall, County-Area respondents prefer statutory systems

[23]There is no indication that central government actors play a larger in allocating land or promoting external investment in the County Area. If anything, the central government has had greater allocative authority in the Hinterland, where large areas were designated as "public lands" (Bruce 2008).

to customary or hybrid systems. The institutional boundary affects contemporary attitudes towards customary leadership and land—a key premise of our theory.[24]

7. Case study: Golden Veroleum Liberia (GVL)

These discoveries notwithstanding, our quantitative findings do not reveal how customary authorities interact with external investors and why these negotiations fail to generate more concession activity. To address this limitation, we analyze qualitative data on an agribusiness concession between 2010 to the present. Our case study of Golden Veroleum Liberia (GVL) makes two contributions. First, it validates our claims about how property rights systems shape external investment. We document why transactions costs are higher under the customary system, and also find that customary authorities can attract investment by promising (not always credibly) to displace local land holders and free up large, cheap tracts of land. Second, the case study suggests an extension of our formal model; in particular, we find that international organizations can help communities to hold their customary authorities accountable and thereby prevent sweetheart deals for investors.[25]

7.1 Background

GVL is "owned by the US-based Verdant Fund LP, whose sole investor is Singapore-listed palm oil giant Golden Agri-Resources, the world's second-largest palm oil plantation company. It became Liberia's biggest palm oil investor in 2010" (Valdmanis 2013).[26] Signed in 2010 and reportedly worth 1.6 billion USD, the concession agreement identifies 350,000 hectares (ha) in southeastern

[24] We do not find that individuals report greater land conflict in the Hinterland, which might have deterred external investors.

[25] We preregistered our hypotheses and qualitative analysis plan prior to deciding which agribusiness concession to study or viewing any of the qualitative data on this concession. We completed only one case study due to source constraints.

[26] We selected GVL as a case, because (1) it is one of the largest concessions during our study period; and (2) a feasibility check revealed enough sources to plausibly code the variables of interest.

Liberia, including land in Sinoe and River Gee counties.[27] By 2015, 210,382 ha had been identified for plantations. The concession agreement does not discuss the treatment of existing land holders or even acknowledge that such individuals exist.

GVL's presence in Liberia has been marked by controversy, and complaints focus on GVL's treatment of prior land users in the concession area. In 2011 advocacy organizations, including the Sustainable Development Institute (SDI) and its international supporters, helped community members file a formal complaint to the Roundtable on Sustainable Palm Oil (RSPO) about the absence of Free Prior and Informed Prior Consent (FPIC) processes for accessing land within the concession area. The result of this complaint was a 2013 investigation by the The Forest Trust (TFT) that appears to have significantly changed GVL's operations in Liberia. Evidence of this change include the publication of GVL's new Standard Operating Procedures for working in the concession areas and community-by-community Memoranda of Understanding (MoUs) that detail how GVL will engage with communities and use their land.

7.2 Transaction Costs

GVL's experience provides evidence of high transaction costs under the customary property rights system due to the involvement of local authorities and the illegibility of existing land rights.

GVL struggled from the outset to understand existing ownership and usufruct rights. In 2010, the Liberian central government lacked a clear process for awarding concessions that included communal land. Even five years after GVL's agreement, Global Witness (2015: 12) reports that "Liberia's rapid agricultural expansion is taking place in a legal vacuum with companies governed only by voluntary promises and the concession agreements they sign with the government, many of which risk violating international laws, such as those protecting community land rights." Per-

[27] The agreement is signed by the Ministers of Agriculture and Finance, the chairman of the National Investments Commission and attested to by the Minister of Justice (Lomax 2012: 15).

haps unsurprisingly then, GVL's concession agreement completely omits mention of customary authorities or communally-held land (Ministry of Foreign Affairs 2010). This is not an indication of customary authorities' diminished role; from 2013 onward, the company was heavily engaged with customary authorities. Rather, it reflects the company's decision to not formally engage such authorities, but instead to provide side payments (described below) to selected local elites (RSPO 2012).

After acknowledging local leaders' role in accessing land and facing criticism from civil society for failing to respect the rights of prior tenants, GVL began entering into MoUs, community-level plans that describe the terms of investment. These MoUs, which begin in 2013, include records of numerous community meetings, refer to boundary demarcation exercises, describe compensation, and include pages of community leaders' signatures (in many cases a smudged thumbprint).[28] The process of meetings, mappings, and attaining signatures from leaders (paramount and local chiefs, elders, and others) in each community generated significant costs and delayed clearing and planting activities (Wright and Tumbey 2012). GVL's own Standard Operating Procedures for FPIC, established in response to outcry over the displacement of existing land holders, include 41 steps and produces 21 different indicators that must be monitored (Golden Veroleum 2013).

While these MoUs are not leases, the documents specify a price per hectare and other benefits that GVL will provide. The community's portion of the surface rents are typically paid into a community account, which the chief oversees (as opposed to individual land holders' accounts). Customary authorities not only administer this fund, they also sometimes receive side-payments for helping to conclude the MoU. For example, GVL rented a building in Sinoe County from Milton Teahjay, a local official who later became a senator, for 18,000 USD, three times the estimated market rate (Global Witness 2015: 6). GVL also rented a building from former Senator

[28] See Golden Veroleum MoUs from October 2013 through February 2017 (link).

Mobutu Nhenphan for 35,000 USD (Global Witness 2015: 6). This resembles our model, in which unaccountable local authorities can rent-seek rather than distribute benefits to land holders.

7.3 Displacement

In a report entitled "What does the contract say: Golden Veroleum Liberia," SDI notes that within GVL's concession there are no protections for land users and that displacement is likely (Sustainable Development Institute 2010: 10). The agreement stipulates that GVL can "request that certain settlements be relocated if [it] can demonstrate to Government's satisfaction that such existing settlements and their inhabitants would impede [GVL's] development of the Concession Area and would interfere with operations" (Lanier, Mukpo, and Wilhelmsen 2012: 52).

At least initially, it appears that GVL anticipated the forced displacement of prior land holders, lowering the projected expense and making the investment more attractive. It can sometimes be difficult to identify forced displacement, due to disagreements about whether (adequate) compensation was paid to resettled households. However, GVL concedes that forced displacement took place between September 2010 and January 2013 (Valdmanis 2013). The details come from the report by The Forest Trust (TFT), which was brought in to investigate allegations that GVL was not adhering to the FPIC standards that their parent company promised. TFT reports 16 cases where GVL took land from existing users without permission (The Forest Trust 2013).

The extent of displacement was limited by a prompt response from communities and advocacy organizations. In 2011, only a year after the concession agreement was signed, affected community members submitted a formal complaint to the RSPO prompting an investigation into GVL's process for accessing land. Following the investigation, the company promulgated new SOPs and embarked on negotiating the community-specific MOUs. In 2015, Global Witness published a report stating, "Liberia is on the brink of a land grabbing crisis [. . .] This report shows how Liberians are reported to have been violently beaten, threatened, and arrested for protesting the expansion

of Golden Veroleum" (Global Witness 2015: 5). The prospect of cheaply displacing existing land holders may have attracted GVL to land under customary control. Yet, any hope of savings quickly dissipated, as affected community members and activists contested efforts to grab land without adequate compensation. This reduced the attractiveness of investing in land held under the customary property rights system.

8. Conclusion

This paper addresses two intersecting debates in the political economy of development: whether private property encourages external investment, or whether customary authorities use their control of land to facilitate large-scale acquisitions.

We propose a model that can rationalize conflicting claims about which property rights system attracts external investors and why. If investors are sensitive to the transaction costs that come from the illegibility of customary systems, then we expect demand to be greater where private property prevails. However, if a customary system allows chiefs or other local authorities to depress land prices by effectively expropriating land holders, then investors might be wooed by cheap, if ill-gotten, land.

The net effect of these competing forces is, ultimately, an empirical question. We exploit a natural experiment in Liberia, a country that has seen an influx of external investments in natural resources. Liberian law established parallel private and customary property rights systems. We look at changes in land clearing and concession activity on either side of the institutional boundary following the Global Food Crisis of 2007–8. Our empirical strategy leverages the timing of a major external demand shock to better isolate changes attributable to external investments in land. To bolster our identification strategy, we focus on areas near the institutional boundary with similar

pre-crisis trends in land clearing and comparable agro-climatic, demographic, and socio-economic profiles.

Using fine-grained data from 2001–2014, we find greater rates of forest loss—a measure of land conversion for more intensive uses—in the County Area, where private property exists. Our estimates are roughly half the mean of the dependent variable and similar in magnitude to the change in land clearing that occurred in the first four years of peace after the Liberian Civil War. More direct analyses of the scale of agricultural concessions and clearing within concessions bolster our attribution of the overall effects to external investment, not local consumption. Finally, we show that the institutional boundary reflects on-the-ground differences in the role that customary authorities or prices play in allocating land.

Looking into a major palm oil concession, we uncover qualitative evidence that aligns with our theory and quantitative results. In particular, we find, first, that the involvement of many actors with unclear authority drives up transaction costs in the customary system; and second, that customary authorities initially promised low prices to the concessionaire based on plans to displace existing land holders. Yet, local mobilization augmented by international advocates, increased scrutiny of customary authorities and deterred large-scale displacement.

While our findings reveal the role of institutions in enabling large-scale external investment in land, they do not quantify the welfare effects of concessions. Edwards's (2017) recent research into Indonesia's oil palm sector finds that "at least 1.3 million out of the approximately 10 million people lifted from poverty over the 2000s have escaped poverty due to growth in the oil palm sector." This contrasts with more pessimistic accounts about displaced Indonesian land holders' bleak employment prospects (e.g., Li 2011). Building on the initial work from Bunte et al. (2018), careful welfare assessments of the impact of Liberia's concessions are required to understand the consequences of external investment on the everyday lives of Liberians. Lanier, Mukpo, and Wil-

helmsen's (2012) case studies of oil palm and iron ore concessions in Liberia raise concerns about inadequate compensation for land holders, limited positive spillovers, and corruption.

References

Abood, Sinan A, et al. 2015. "Relative Contributions of the Logging, Fiber, Oil Palm, and Mining Industries to Forest Loss in Indonesia". *Conservation Letters* 8 (1): 58–67.

Acemoglu, Daron, Tristan Reed, and James A Robinson. 2014. "Chiefs: Economic Development and Elite Control of Civil Society in Sierra Leone". *Journal of Political Economy* 122 (2): 319–368.

Albertus, Michael. 2019. "The effect of commodity price shocks on public lands distribution: Evidence from Colombia". *World Development* 113:294–308.

Ali, Daniel, Klaus Deininger, and Anthony Harris. 2019. "Does large farm establishment create benefits for neighboring smallholders? Evidence from Ethiopia". *Land Economics* 95 (1): 71–90.

Baldwin, Kate. 2013. "Why Vote with the Chief? Political Connections and Public Goods Provision in Zambia". *American Journal of Political Science* 57 (4): 794–809.

Besley, Timothy, and Torsten Persson. 2011. *Pillars of Prosperity*. Princeton University Press.

Boone, Catherine. 2014. *Property and Political Order in Africa: Land Rights and the Structure of Politics*. Cambridge University Press.

Bubb, Ryan. 2015. "The Evolution of Property Rights: State Law or Informal Norms?" *The Journal of Law and Economics* 56 (3): 555–594.

Bunte, Jonas B., et al. 2018. "Natural resource sector FDI, government policy, and economic growth: Quasi-experimental evidence from Liberia". *World Development* 107:151–162.

Card, David, and Alan B Krueger. 2000. "Minimum wages and employment: a case study of the fast-food industry in New Jersey and Pennsylvania: reply". *American Economic Review* 90 (5): 1397–1420.

Cattaneo, Matias D, Brigham R Frandsen, and Rocio Titiunik. 2015. "Randomization Inference in the Regression Discontinuity Design: An Application to Party Advantages in the U.S. Senate". *Journal of Causal Inference* 3 (1): 1–24.

Christy, Cuthbert. 1931. "Liberia in 1930". *The Geographical Journal* 77 (6): 515–540.

Conley, Tim. 1999. "GMM Estimation with Cross Sectional Dependence". *Journal of Econometrics* 92:1–45.

Cotula, Lorenzo. 2012. “The international political economy of the global land rush”. *The Journal of Peasant Studies* 39 (3-4): 649–680.

Deininger, Klaus. 2011. “Challenges posed by the new wave of farmland investment”. *Journal of Peasant Studies* 38 (2): 217–247.

Deininger, Klaus, and Derek Byerlee. 2011. *Rising Global Interest in Farmland*. The World Bank.

Edwards, Ryan. 2017. “Tropical Oil Crops and Rural Poverty”. *Working Paper*: 1–77.

French, Howard W. 2014. *China’s Second Continent: How a Million Migrants Are Building a New Empire in Africa*. Knopf.

Frieden, Jeffry A. 1994. “International investment and colonial control: a new interpretation”. *International Organization* 48 (4): 559–593.

Gaveau, David L A, et al. 2016. “Rapid conversions and avoided deforestation: examining four decades of industrial plantation expansion in Borneo”. *Scientific Reports* 6 (): 32017.

Guan, Kaiyu, et al. 2015. “What aspects of future rainfall changes matter for crop yields in West Africa?” *Geophysical Research Letters* 42 (19): 8001–8010.

Hansen, M C, et al. 2013. “High-Resolution Global Maps of 21st-Century Forest Cover Change”. *Science* 342 (6160): 850–853.

Hijmans, Robert J, et al. 2005. “Very high resolution interpolated climate surfaces for global land areas”. *International Journal of Climatology* 25 (15): 1965–1978.

Jensen, Nathan. 2008. “Political Risk, Democratic Institutions, and Foreign Direct Investment”. *The Journal of Politics* 70 (4): 1040–1052.

Kabia, Fatmata S. 2014. “Behind the Mirage in the Desert—Customary Land Rights and the Legal Framework of Land Grabs”. *Cornell International Law Journal* 47:709–734.

Li, Quan, Erica Owen, and Austin Mitchell. 2018. “Why do democracies attract more or less foreign direct investment? A metaregression analysis”. *International Studies Quarterly* 62 (3): 494–504.

Li, Quan, and Adam Resnick. 2003. “Reversal of Fortunes: Democratic Institutions and Foreign Direct Investment Inflows to Developing Countries”. *International Organization* 57 (1): 175–211.

Li, Tania Murray. 2011. “Centering labor in the land grab debate”. *Journal of Peasant Studies* 38 (2): 281–298.

Logan, Carolyn. 2013. “The roots of resilience: Exploring popular support for African traditional authorities”. *African Affairs* 112 (448): 353–376.

Milner, Helen V. 2014. “Introduction: The Global Economy, FDI, and the Regime for Investment”. *World Politics* 66 (1): 1–11.

Pandya, Sonal S. 2016. “Political Economy of Foreign Direct Investment: Globalized Production in the Twenty-First Century”. *Annual Review of Political Science* 19 (1): 455–475.

Rosenau, William, et al. “Corporations and Counterinsurgency”. *RAND Corporation Occassional Paper*. https://www.rand.org/pubs/occasional_papers/OP259.html.

Schoneveld, George C. 2017. “Host country governance and the African land rush: 7 reasons why large-scale farmland investments fail to contribute to sustainable development”. *Geoforum* 83:119–132.

Scott, James C. 1999. *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press.

Stevens, Caleb J. 2014. “The Legal History of Public Land in Liberia”. *Journal of African Law* 58 (2): 250–265.

Unruh, Jon D. 2008. “Catalyzing the Socio-Legal Space for Armed Conflict: Land and Legal Pluralism in Pre-War Liberia”. *Journal of Legal Pluralism*: 1–31.

Valdmanis, Richard. 2013. “Largest Liberian palm oil project is failing locals”. *Reuters*.

Wily, Liz Alden. 2012. “Looking back to see forward: the legal niceties of land theft in land rushes”. *The Journal of Peasant Studies* 39 (3–4): 751–775.

— . 2011. “The Law is to Blame: The Vulnerable Status of Common Property Rights in Sub-Saharan Africa”. *Development and Change* 42 (3): 733–757.

Technical Reports and Primary Sources

Bruce, John. 2008. *Land Tenure in Post Conflict Liberia*.

De Wit, Paul. 2012. *Land Inventory and Land Management Planning in Sinoe County*.

Global Witness. 2015. *The New Snake Oil: Violence, threats and false promises at the heart of Liberia's Palm Oil Expansion*.

Golden Veroleum. 2013. *Free prior informed consent (FPIC) Documents and Monitoring Matrix*.

Government of Liberia. 1956. *Liberian Code of Laws 1956*.

Knight, Rachael, et al. 2012. *Protecting Community Lands: Evidence from Liberia, Mozambique and Uganda*.

Lanier, Frazer, Ashoka Mukpo, and Frithiof Wilhelmsen. 2012. *Smell-no-taste: The social impact of foreign direct investment in Liberia*.

Lawry, Steven. 2012. *Land Tenure, Land Policy and Agricultural Development in Liberia*.

Lomax, Tom. 2012. *Human rights based analysis of the agricultural concession agreements between Sime Darby and Golden Veroleum and the Government of Liberia*.

Ministry of Foreign Affairs. 2010. *An Act to Ratify the Concession Agreement Between Golden Veroleum and the Government of the Republic of Liberia*.

Nolte, Kerstin, Wytske Chamberlain, and Markus Giger. 2016. *International Land Deals for Agriculture*.

RSPO. 2012. *Annual Communication of Progress Report: Golden Veroleum Liberia 2012/2013*.

Sustainable Development Institute. 2010. *What does the contract say: Golden Veroleum Liberia*.

The Forest Trust. 2013. *Independent Assessment of Free and Prior Informed Consent Process Golden Veroleum (Liberia) Inc.*

USAID. 2016. *Property Rights and Resource Governance: Liberia*.

Wily, Liz Alden. 2007. *So Who Owns the Forest?*

World Bank Justice for the Poor Program, United Nations Development Program, and United Nations Peace Building Support Office. 2015. *Citizen Engagement in Liberia's Natural Resource Concessions: improving equity and mitigating conflict*.

Wright, Solomon P., and E. Abraham Jr. Tumbey. 2012. *Assessment of High Conservation Values Report: Priority Planting Areas 5,000, & 7,000 hectares in Butaw District and 8,000 Hectares in Kpanyan District, Sinoe County, Republic of Liberia*.

Supporting Information

Legibility and External Investment: An Institutional Natural Experiment in Liberia

Following text to be published online.

Contents

A. Formal Model: Game Tree

Figure A.1: Land Investment under Private Property vs. Customary Systems

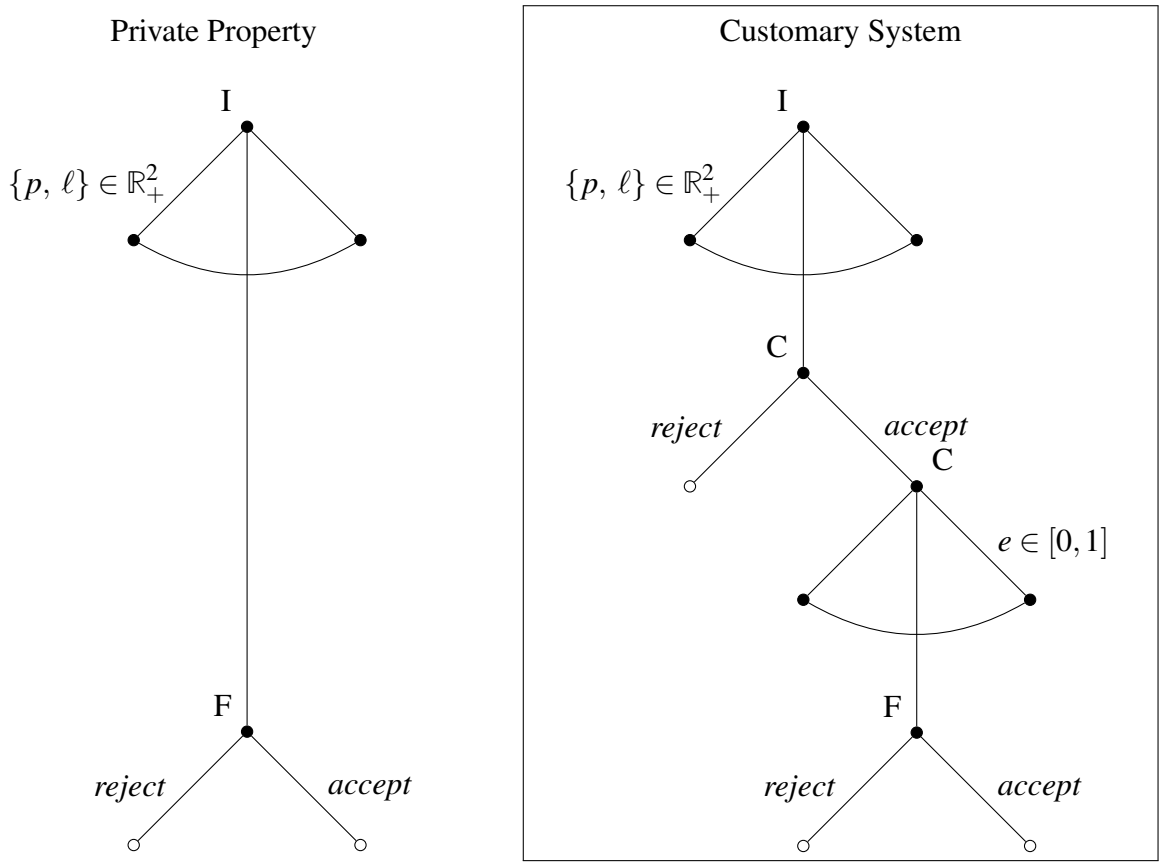


Figure A.1: extensive form of the models presented in Section 2. I represents the investor; F, land holders; and C, the chief. p, ℓ, and e are variables representing the unit price that the investor offers to pay, the amount of land they offer to lease, and the share of the offer value that the chief consumes, respectively.

B. Global Trends in Commodity Prices and Land Investments

B.1 Commodity Prices

Figure A.2: World Prices for Rubber and Palm Oil

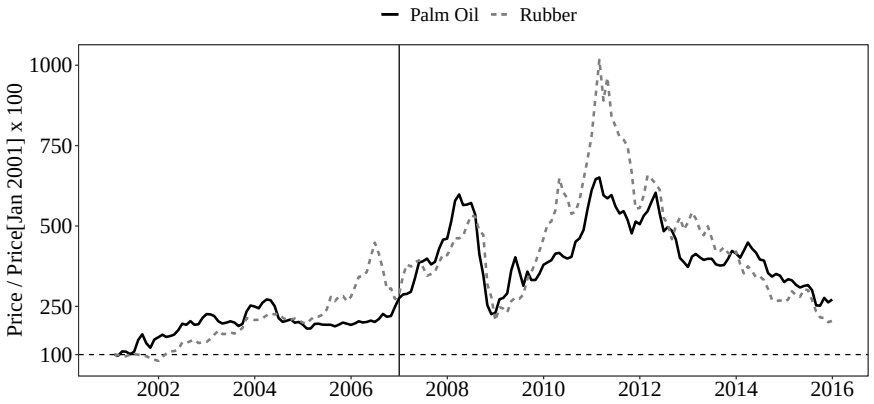


Figure A.2: monthly rubber (dashed) and palm oil (solid) prices come from the International Monetary Fund, "Global price of Rubber" [PRUBBUSDM] and "Global price of Palm Oil" [PPOILUSDM]; retrieved from FRED, Federal Reserve Bank of St. Louis (fred.stlouisfed.org).

Figure A.3: FAO Food Price Indexes

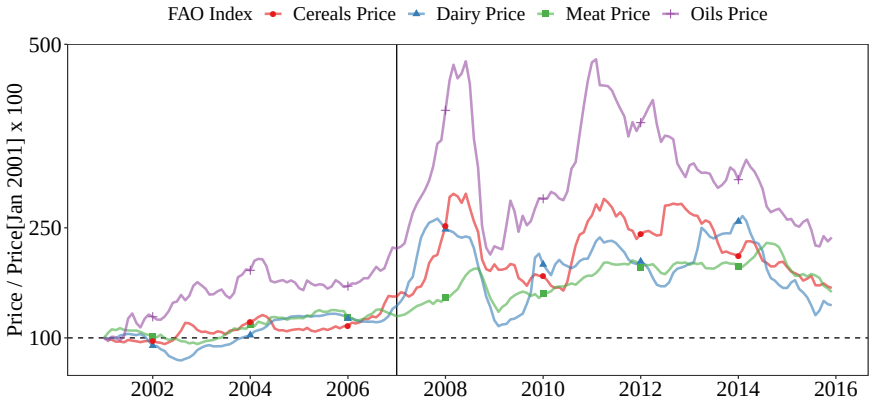


Figure A.3: monthly international prices for baskets of food commodities, weighted by the average export shares of each of the baskets for 2002-2004 (http://www.fao.org/worldfoodsituation/foodpricesindex/en/). The "Oils" index is a basket of 10 different vegetable oils (e.g., soybean, coconut, palm, etc.).

B.2 Land Investments

To be included in the Land Matrix, deals must entail a transfer of land for eventual commercial use, be initiated after 2000, and cover an area of at least 200 hectares.

Figure A.4: Cumulative Land Investment Deals; Source: Land Matrix

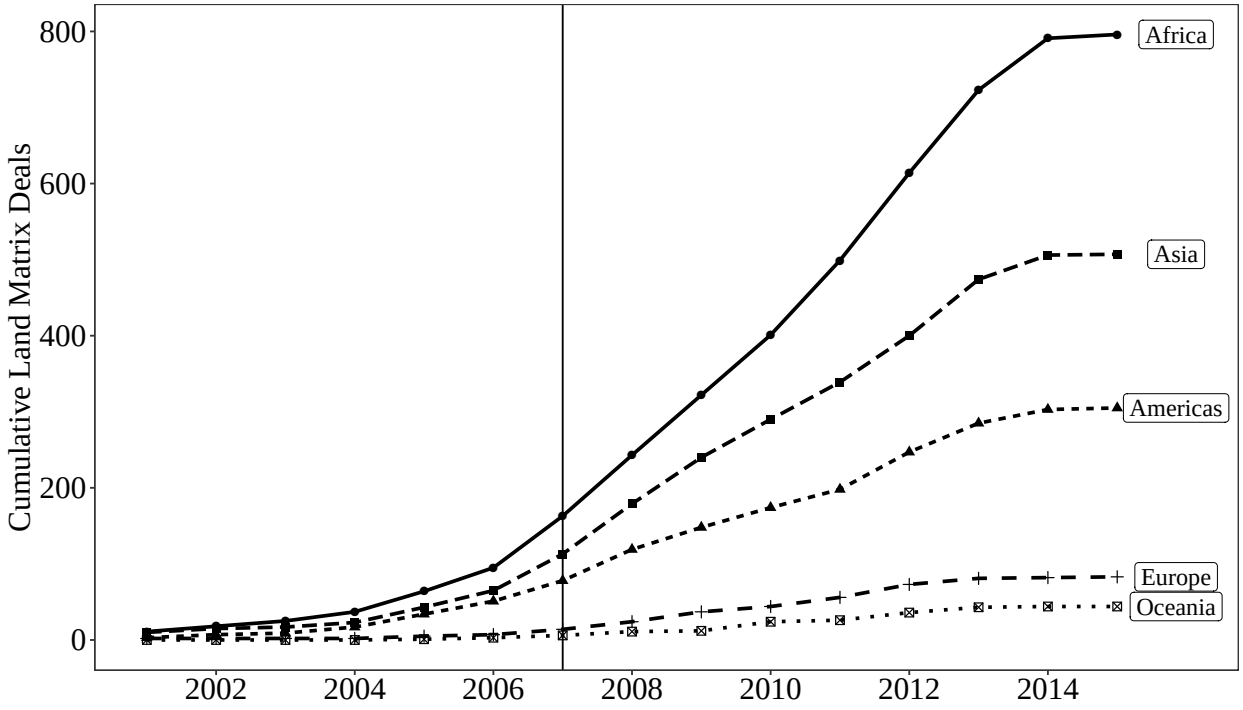


Figure A.4: cumulative land investments according to the Land Matrix (https://landmatrix.org/). We use the implementation date of the deal to code the year of investment. A spatial merge was used to place projects within countries; 2 percent of projects do not fall within country boundaries.

C. Results

C.1 Forest Loss within and outside of Concessions

Results in Table A.1 indicate that forest loss increases dramatically after a cell is incorporated into an agricultural concession.

Table A.1: Forest Loss and Concession Activity

	Dependent variable:			
	Cumulative Forest Loss			
	(1)	(2)	(3)	(4)
𝟙(Agricultural)	0.027^{**}	0.013	0.016^{**}	0.015^{**}
	(0.009)	(0.009)	(0.007)	(0.008)
𝟙(Forestry)	-0.026^{**}	-0.039^{**}	-0.015^{**}	-0.028^{**}
	(0.005)	(0.005)	(0.005)	(0.006)
𝟙(Mining)	0.010	−0.005	−0.001	−0.002
	(0.007)	(0.006)	(0.005)	(0.005)
Mean(y_{it})	0.029	0.04	0.029	0.04
Drop Southern Counties		✓		✓
Cell FEs	148,544	89,654	148,544	89,654
Year FEs	14	14		
County-Year FEs			196	126
Observations	2,159,122	1,307,026	2,159,122	1,307,026

Table A.1: linear models where the regressors capture whether a cell fell within an active concession area in a given year. Models include cell fixed effects, which absorb 𝟙(County). The sample is limited to cells within 40 km of the institutional boundary, and the unit of observation is a $1km^2$ cell observed in each year. The dependent variable is the proportion of each cell that has experienced forest loss using the data from Global Forest Change (see Section 5.1). Robust standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$

Rates of loss in forestry concessions are lower than outside of concession areas. This negative effect is largest for forest management agreements designed to promote conservation, but we estimate significantly reduced rates of loss under all types of forestry concessions, including Timber Sales Contracts, which permit clear cutting. Even by 2016 (two years after our study period) most Timber Sales Contracts still have not become fully active: "[commercial] logging operations are not yet fully up to scale and impact on forest should be gradual as extraction rates should be kept at or close to sustainable limits" (Rivard 2016: 31). Compare this to areas outside of concession areas, where swidden (i.e., slash-and-burn) agriculture and unregulated chainsaw milling erode

forest cover. Estimates in Table A.1 suggest that mining concessions do not meaningfully affect on forest loss.

C.2 Extensive Margin: Differential Expansion of Agricultural Concessions

Table A.2: Expansion of Agricultural Concessions (Extensive Margin)

	Dependent variable:					
	𝟙(Agricultural Concession)					
	(1)	(2)	(3)	(4)	(5)	(6)
𝟙(County)	0.071*	0.101*				
	(0.037)	(0.055)				
D_{it}			0.057*	0.083	0.077**	0.113**
			(0.034)	(0.051)	(0.029)	(0.045)
Constant	0.067**	0.105**				
	(0.029)	(0.042)				
Mean(y_{it})	0.103	0.156	0.048	0.075	0.048	0.075
Drop Southern Counties		✓		✓		✓
Cell FEs	0	0	148,544	89,654	148,544	89,654
Year FEs			14	14		
County-Year FEs					196	126
Observations	154,223	93,359	2,159,122	1,307,026	2,159,122	1,307,026

Table A.2: linear probability models estimated using cross-sectional data from 2014 (models 1-2) or panel data (models 3-6). All panel models include cell and year or county-year fixed effects. The sample is limited to cells within 40 km of the institutional boundary, and the unit of observation is a 1km^2 cell observed in each year. The dependent variable is whether the cell falls within an active agricultural concession (models 1-4) or any concession (models 5-6). In the even-numbered models, we drop the southern counties (see Figure 1). Robust standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

C.3 Intensive Margin: Forest Loss within Concessions

To analyze the intensive margin, we amend our panel model, estimating instead:

$$y_{it} = \alpha_i + \gamma_t + \delta \mathbb{1}(\text{Agric.})_{it} + \phi \mathbb{1}(\text{Agric.})_{it} \times \mathbb{1}(\text{County})_i + \varepsilon_{it} \tag{3}$$

where $\mathbb{1}(\text{County})$ is absorbed by the cell fixed effects. $\mathbb{1}(\text{Agric.})_{it}$ indicates whether a cell falls within an agricultural concession. δ is the difference-in-differences for the effect of concessions on forest loss in the Hinterland. ϕ indicates how much larger that effect is in the County Area.[29]

Table A.3: Forest Loss within Agricultural Concessions (Intensive Margin)

	Dependent variable:						
	Cumulative Forest Loss						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}$(Agric.)	0.047**	0.026	0.066**	0.015**	0.001	0.024**	0.015
	(0.017)	(0.018)	(0.018)	(0.006)	(0.006)	(0.007)	(0.011)
$\mathbb{1}$(County)	0.023**	0.036**	0.0005				
	(0.010)	(0.013)	(0.010)				
$\mathbb{1}$(Agric.) $\times$ $\mathbb{1}$(County)	0.045*	0.041	0.068**	0.024**	0.027**	0.023**	0.027**
	(0.026)	(0.029)	(0.030)	(0.010)	(0.011)	(0.010)	(0.011)
Constant	0.052**	0.075**	0.032**				
	(0.009)	(0.011)	(0.009)				
Mean(y_{it})	0.071	0.101	0.073	0.029	0.04	0.03	0.038
Drop Southern Counties		✓			✓		✓
Eventual Concession Areas			✓			✓	✓
Cell FEs	0	0	0	148,544	89,654	42,161	29,800
Year FEs	0	0	0	14	14	14	14
Observations	154,223	93,359	43,970	2,159,122	1,307,026	615,580	434,392

Table A.3: linear probability models estimated using cross-sectional data from 2014 (models 1-3) or panel data (models 4-7). The sample is limited to cells within 40 km of the institutional boundary, and the unit of observation is a 1km^2 cell observed in each year. The dependent variable is the proportion of each cell that has experienced forest loss using the data from Global Forest Change (see Section 5.1). In models (2), (5), and (7), we drop the southern counties (see Figure 1); in models (3), (6), and (7), we limit the sample to cells that eventually become part of concessions. Robust standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

[29] These conditional-on-positives estimates are subject to confounding if property rights systems change the types of concessions on both sides of the boundaries (Angrist and Pischke 2009: 99).

C.4 Regression Discontinuity Design

We also employ a regression discontinuity design using cross-sectional data on cumulative forest loss in 2006 before the Global Food Crisis and in 2014 at the end of our study period. As noted above, the 40-mile boundary is not a strictly enforced border, but rather a rough dividing line between Liberia's two property rights systems (Bruce 2008). This generates significant interference (i.e., spillovers) right at the 40-mile boundary. Table A.5 illustrates this point; we estimate a standard regression discontinuity specification and then "donut" regression discontinuities, which omit observations within 2 through 8 kilometers of the boundary. To create a buffer that accounts for spillover effects, we opt for a donut regression discontinuity that excludes the first 8 kilometers (5 miles) on each side of the institutional boundary, though our results are robust to using a 6 kilometer donut (less than 4 miles).

Figure A.5 plots average cumulative forest loss on each side of the institutional boundary (bin width = 1 km) in 2001, 2006, and 2014. Forest loss levels are comparable on both sides of the institutional boundary in 2001 and 2006. However, the increase between 2006 and 2014—before and after the Global Food Crisis—is considerably larger in the County Area. This analysis excludes the southern counties, where the 40-mile boundary does not correspond to historic divisions between the property rights systems.[30]

Using methods developed by Calonico, Cattaneo, and Titiunik (2014), we estimate the optimal bandwidth to be 7 kilometers. We restrict attention to cells within this bandwidth and estimate the regression discontinuity using a model that is linear in the forcing variable (i.e., a local linear regression). Our primary models include distance to the institutional boundary as the forcing variable, which is interacted with the treatment indicator.[31] As a robustness check, we substitute latitude and longitude as forcing variables. We include county fixed effects (i.e., boundary-segment fixed effects, with segments determined by county boundaries) in selected models. Standard errors are clustered on district to account for spatial dependence.

[30] First, Liberia did not originally include the Southeast, which was a separate colony settled by the Maryland Colonization Society (Akpan 1973). This colony had its own governance structure and was not annexed by Liberia until 1857, 35 years after the founding of Liberia (Laughon 1941). Second, as Unruh (2008) notes, the 40-mile boundary codified a practice of providing fee simple titles to Liberia's early settlers, members of the American Colonization Society who occupied the Northwest. As both the settlers and extents of inland settlement differed in the Southeast, the 40-mile boundary in this part of the country does not overlap with the historic titling efforts that established private property rights.

[31] More precisely, the forcing variable is the distance to the edge of the donut.

Figure A.5: Cumulative Forest Loss at Varying Distances from the Boundary

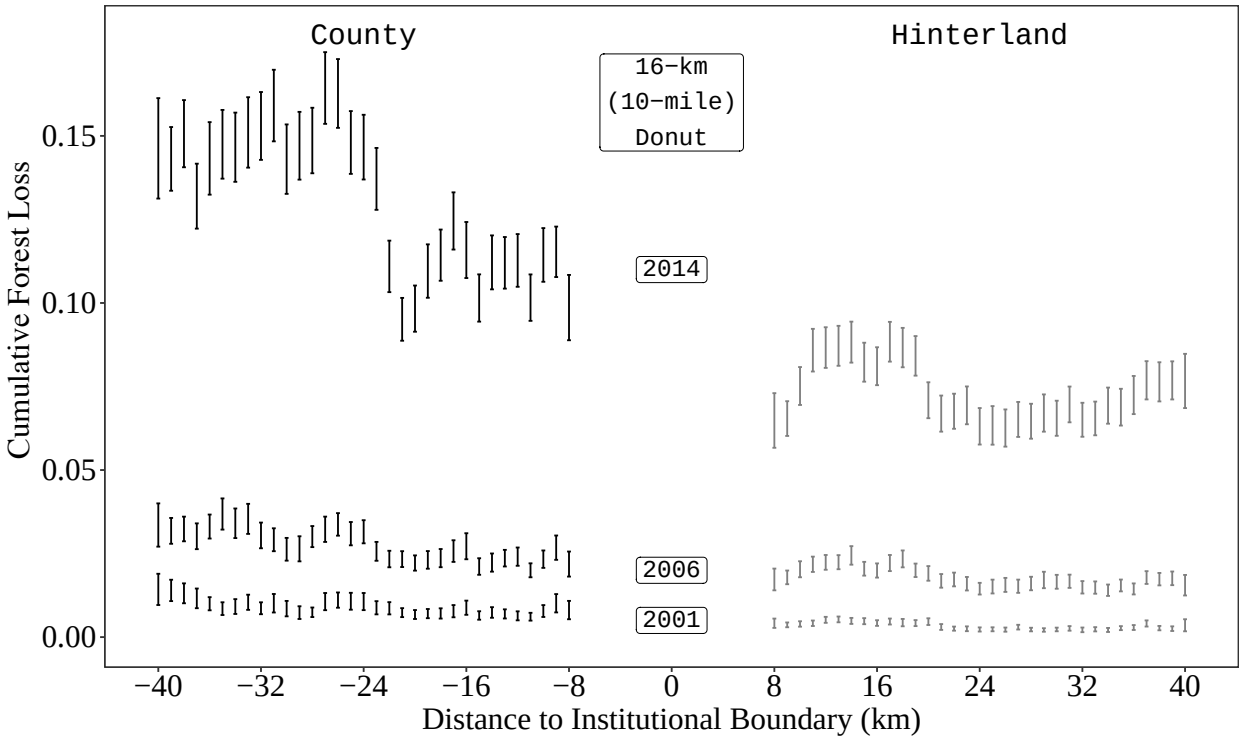


Figure A.5: we create 1-km bins of cells based on their distance from the institutional boundary. Bars represent the 95% confidence intervals around average forest loss in each bin. Bars at the bottom of the figure are the means in 2001; above that, in 2006; and the uppermost series, in 2014. Consistent with the donut RD we estimate, we exclude 8 km (5 miles) on either side of the boundary.

Focusing on models 3–4 in Table A.4, which include county fixed effects, we find no difference between the County and Hinterland sides of the institutional boundary in 2006, before the Global Food Crisis. However, by 2014, we find significantly greater clearing—a 3 percentage point difference—in the County Area. These models leverage grid cells within 15 kilometers of the institutional boundary and restrict attention to within-county comparisons.Table A.5 shows that our results are robust to using a smaller donut of 6 kilometers (model 8).

These RD results present a qualitatively similar picture as the difference-in-differences results. We estimate larger coefficients with the RD strategy for two reasons: (1) the RD evaluates cumulative effects in 2014, rather than averaging all interim years; and (2) the RD coefficients also incorporate small (insignificant) level differences that emerge prior to the Global Food Crisis.

Table A.4: Regression Discontinuity before and after the Global Food Crisis

	Dependent variable:							
	Cumulative Forest Loss							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
𝟙(County)	0.007	0.043**	0.005	0.033**	0.036**	0.165**	0.006	0.063*
	(0.005)	(0.015)	(0.003)	(0.011)	(0.010)	(0.044)	(0.011)	(0.037)
Year	2006	2014	2006	2014	2006	2014	2006	2014
Distance to Boundary	✓	✓	✓	✓				
Lat. and Long.					✓	✓	✓	✓
County FEs			9	9			9	9
Observations	16,138	16,138	16,138	16,138	16,138	16,138	16,138	16,138

Table A.4: local linear regression restricted to a bandwidth of 7 km, selected optimally per Calonico, Cattaneo, and Titiunik (2014). Models 3–4 and 7–8 include county fixed effects. In models 1–4, the forcing variable is euclidean distance to the institutional boundary interacted with the treatment indicator. In models 5–8, the forcing variables are latitude and longitude. Odd columns use cross-sectional data from 2006, before the Global Food Crisis; even columns from 2014, after the Global Food Crisis. Robust standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

Table A.5: Regression Discontinuity Results with Varying Donut Sizes

	Dependent variable:									
	Cumulative Forest Loss									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
𝟙(County)	0.005*	−0.011	−0.006*	−0.023	−0.005	0.003	0.002	0.038**	0.005	0.033**
	(0.003)	(0.010)	(0.003)	(0.020)	(0.006)	(0.021)	(0.004)	(0.013)	(0.003)	(0.011)
Year	2006	2014	2006	2014	2006	2014	2006	2014	2006	2014
Donut Size	0 km	0 km	2 km	2 km	4 km	4 km	6 km	6 km	8 km	8 km
County FEs	9	9	9	9	9	9	9	9	9	9
Observations	16,042	16,042	16,077	16,077	16,099	16,099	16,134	16,134	16,138	16,138

Table A.5: local linear regression with county fixed effects restricted to a bandwidth of 7 km. The forcing variable is euclidean distance to the institutional boundary interacted with the treatment indicator. Odd columns use cross-sectional data from 2006, before the Global Food Crisis; even columns from 2014, after the Global Food Crisis. Robust standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

C.5 Placebo Crises

We estimate equation (2) using data from 2001-2007 and coding D_{it} using years prior to the actual crisis. These "placebo" crises consistently generate null findings, indicating that cells on either side of the boundary do not follow divergent trends prior to 2008. The right-most result uses the actual crisis and is identical to the coefficient from Table 1, model 2.

Figure A.6: Placebo Results using Years Before the Food Crisis

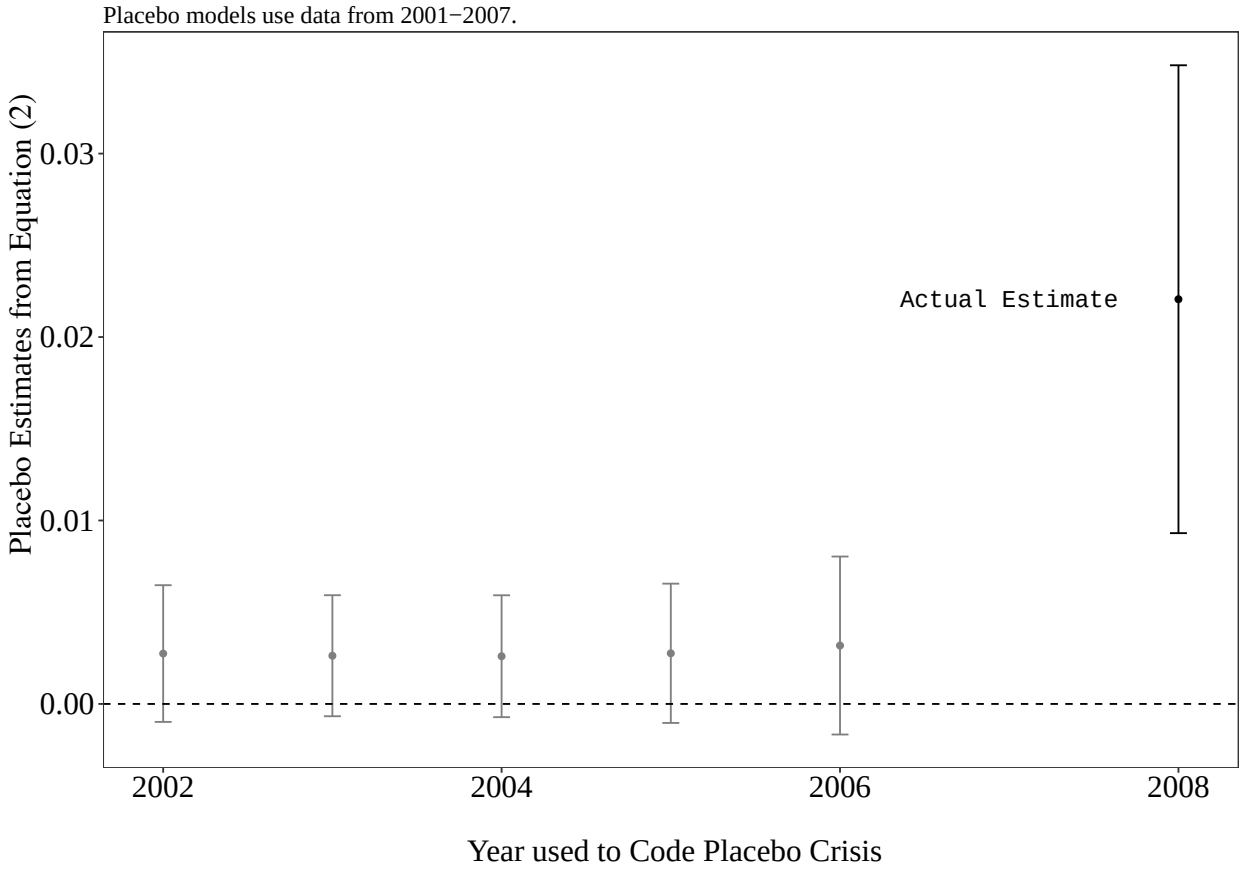


Figure A.6: point estimates and 95% confidence intervals for $\hat{\beta}$ from equation (2) coding years prior to the Global Food Crisis as "placebos." We cannot use 2007 as a placebo crisis, as there would be no post-treatment data that does not overlap with the true post-treatment period.

C.6 Placebo Boundaries

Figure A.7: Map of Placebo Boundaries

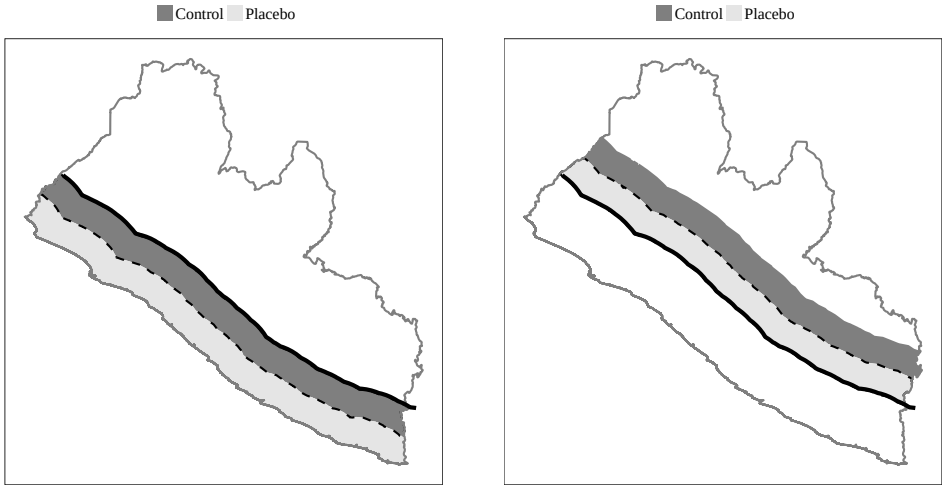


Figure A.7: we shift the boundary 20 miles towards the coast (left) or further inland (right) to construct "placebo" boundaries. These maps illustrate the areas coded as "treated" and "control" when use these placebo boundaries that are 20 and 60 miles from the coast, respectively.

Figure A.8: Trends in Forest Loss across Actual and Placebo Boundaries

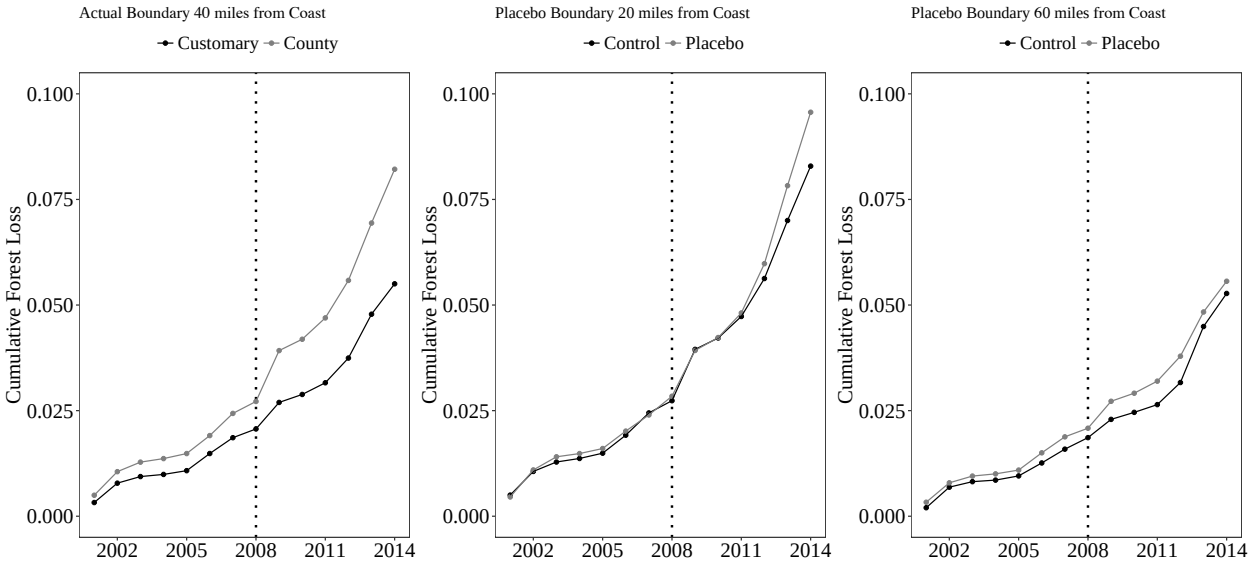


Figure A.8: we recreate Figure 3 using the actual institutional boundary, 40 miles from the coast (left); a placebo boundary 20 miles from the coast (center); and a placebo boundary 60 miles from the coast (right). The bandwidth around these boundaries is the same (32 km) for all three figures.

C.7 Alternative Bandwidths around Institutional Boundary

Table A.6: Robustness: Bandwidth Choices

	Dependent variable:		
	Cumulative Forest Loss		
	(1)	(2)	(3)
$\mathbb{1}$(County) $\times$ Post-2007 (D_{it})	0.022	0.018	0.009
Clustered on District	$(0.007)^{**}$	$(0.007)^{**}$	(0.006)
Spatial HAC (10 year, 50 km)	$(0.003)^{**}$	$(0.003)^{**}$	$(0.002)^{**}$
Bandwidth	40 km	30 km	20 km
Mean(y_{it})	0.04	0.039	0.038
Drop Southern Counties	✓	✓	✓
Cell FEs	89,654	67,840	45,868
Year FEs	14	14	14
Observations	1,255,156	949,760	642,152

Table A.6: reestimation of model 2 from Table 1 using bandwidths around the institutional boundary of 40 km, 30 km, and 20 km. We report standard errors clustered on district, as well as Conley standard errors that account for spatial and temporal autocorrelation. Significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

C.8 Controlling for Census (2008) Variables Interacted with Post-2007

Census microdata have been aggregated to 13,365 geo-coded localities (see Figure A.9). In addition to population counts, the census includes whether the locality is urban; what proportion of residents were displaced, widowed, orphaned, or disabled by the civil war; what proportion of residents are literate, have any school, or are under age 18; and a locality wealth index.[32] The data provide the most comprehensive snapshot of population density, conflict experience, basic education, and wealth in Liberia during our study period.

Figure A.9: 2008 Census Localities

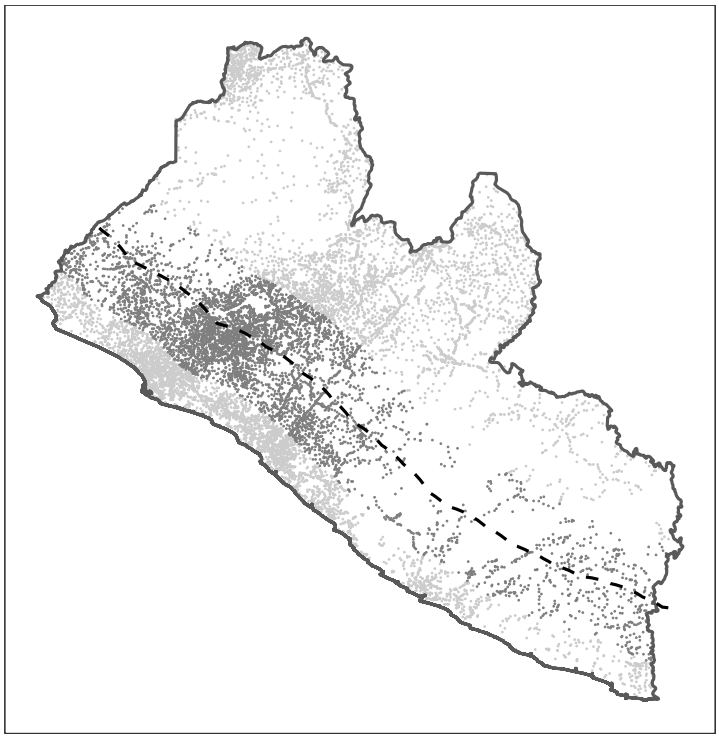


Figure A.9: localities (13,365 total) from the 2008 nationwide Census. The dark grey points fall within 40 kilometers of the institutional boundary, which is represented by the thick dashed line.

To merge our gridded forest-loss data with the 2008 census, we (1) create a two-kilometer buffer around the centroid of each grid cell; (2) identify all census localities that fall within that buffer and are on the same side of the institutional boundary; (3) take the average across those localities for each cell. If a grid cell does not have a census locality within two kilometers of its centroid, then it is dropped from this analysis. Figure A.10 shows the cross-sectional differences across census variables (residualized by County) for grid cells in the County Area vs. Hinterland.

[32]The wealth index is a locality-level average of six asset ownership questions: does the household own furniture, a mattress, radio, tv, cell phone, motorcycle, vehicle, or refrigerator?

Within 40 kilometers of the institutional boundary, we find negligible differences across most measures; only one covariate, the proportion displaced by the war, is significantly higher in the County Area.[33] As the census is cross-sectional, the direct effect of census variables is absorbed by the cell fixed effects in Table A.7.

Figure A.10: Mean Differences in 2008 Census Variables

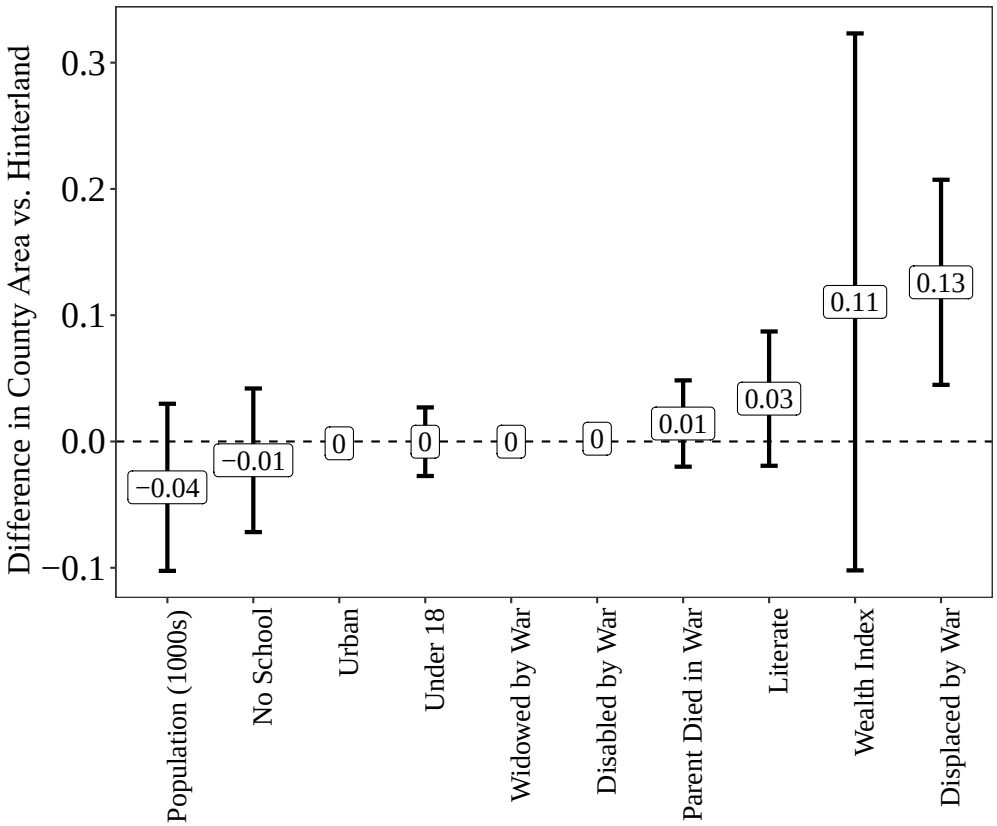


Figure A.10: we restrict attention to localities in our 40-km bandwidth and residualize census variables by county. We then plot the difference in means (95% confidence intervals) between the County Area and Hinterland; standard errors are clustered on county.

[33] Similar to work by Mattingly (2017) or Lee and Schultz (2012), we demonstrate the persistent effects of a historic geographic discontinuity. Unlike these authors, we do not find persistent level differences at the discontinuity — unsurprisingly so, as our institutional boundary does not demarcate areas that were controlled by different colonial powers as in these past works.

Table A.7: Controlling for Census Variables Interacted with Post-2007

	Dependent variable:										
	Cumulative Forest Loss										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
D_{it}	0.012^{**}	0.012^{**}	0.012^{**}	0.010^{*}	0.012^{**}	0.012^{**}	0.012^{**}	0.012^{**}	0.012^{**}	0.013^{**}	0.010^{**}
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Interacted Census Variable(s)	Pop.	Urban	Wealth	Displaced	Widowed	Orphaned	Disabled	Literate	School	Under 18	All
	Observations: 1,115,926		Cell FEs: 79,709		Year FEs: 14		Mean(y_{it}) = 0.046				

Table A.7: reestimation of equation (2) but include the census variables interacted with our post-2007 indicator (T). Standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

Table A.8: Controlling for Census Variables Interacted with Post-2007
(County-Year Fixed Effects)

	Dependent variable:										
	Cumulative Forest Loss										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
D_{it}	0.011^{**}	0.011^{*}	0.010^{*}	0.010^{*}	0.011^{*}	0.011^{*}	0.011^{*}	0.009^{*}	0.010^{*}	0.011^{*}	0.009^{*}
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Interacted Census Variable(s)	Pop.	Urban	Wealth	Displaced	Widowed	Orphaned	Disabled	Literate	School	Under 18	All
	Observations: 1,115,926		Cell FEs: 79,709		County-Year FEs: 196		Mean(y_{it}) = 0.046				

Table A.8: reestimation of equation (2) with county-year fixed effects but include the census variables interacted with our post-2007 indicator (T). Standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

C.9 Controlling for Market Access Variables Interacted with Post-2007

We compute the distance from each cell to Monrovia, to the nearest primary road, and the average distance to the country's four ports (Buchanan, Greenville, Harper, and Monrovia). These are then interacted with our indicator for the post-2007 period; the direct effects are absorbed by the cell fixed effects.

Table A.9: Controlling for Market Access Interacted with Post-2007

	Dependent variable:						
	Cumulative Forest Loss						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D_{it}	0.015^{**}	0.013^{**}	0.011^{**}	0.011^{**}	0.011^{**}	0.016^{**}	0.009^{**}
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)
Dist to Road × Post-2007		-0.001^{**}	-0.001^{**}				
		(0.0002)	(0.0001)				
Dist to Monrovia × Post-2007				-0.0002^{**}	-0.0001		
				(0.00003)	(0.0001)		
Dist to Port × Post-2007						0.0001	-0.0003^{**}
						(0.0001)	(0.0001)
Mean(y_{it})	0.029	0.029	0.029	0.029	0.029	0.029	0.029
Cell FEs	148,544	148,544	148,544	148,544	148,544	148,544	148,544
Year FEs	14	14		14		14	
County-Year FEs			196		196		196
Observations	2,079,616	2,079,616	2,079,616	2,079,616	2,079,616	2,079,616	2,079,616

Table A.9: reestimation of equation (2) but include the market-access variables interacted with our post-2007 indicator. Standard errors clustered on district; significance: $^{*}p < 0.1$, $^{**}p < 0.05$.

C.10 Afrobarometer Data on Land and Traditional Leaders

We retain the respondents in Round 4 (2008) of the Afrobarometer, living in enumeration areas that fall within 40 kilometers of the institutional boundary. These are the dark grey dots near the dashed boundary in Figure A.11. Each dot represents many respondents. Our resulting sample includes 304 respondents, 100 in the Customary Area; 204 on the County side.

The Round 4 instrument includes a number of questions related to traditional leaders and land that were dropped from subsequent survey rounds. We focus on the following questions:

- Q65: *How much influence do traditional leaders currently have in governing your local community?* Indicator: $\mathbb{1}$(A great deal OR Some).

Figure A.11: Round 4 (2008) Afrobarometer Enumeration Areas

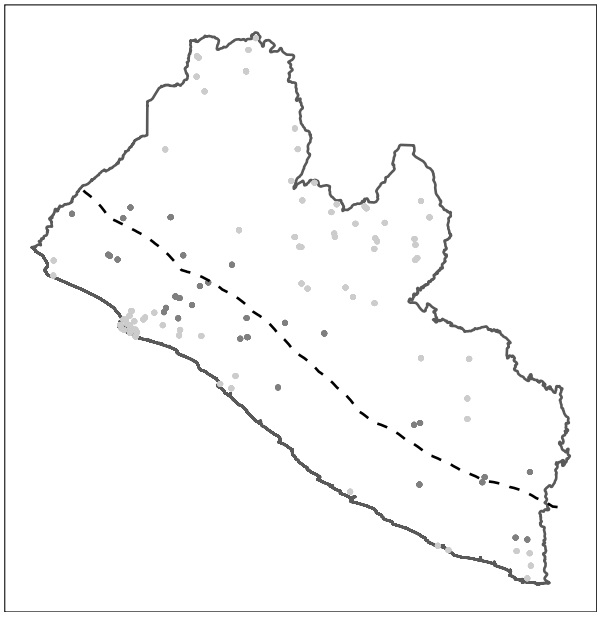


Figure A.11: round 4 enumeration areas (111 total) for the Afrobarometer survey. The dark grey points fall within 40 kilometers of the 40-mile institutional boundary (dashed line).

- Q58: *Who do you think actually has primary responsibility for managing each of the following tasks: solving local disputes (58E), allocating land (58F)?* Indicator: $\mathbb{1}$(Traditional leaders OR Members of the community).
- 75C-LIB: *In your opinion, what is the best way to manage land distribution in Liberia?* Indicator: $\mathbb{1}$(By means of purchase at any price set by the owners of land OR By means of purchase at affordable prices set by the national or local government).
- 76-LIB: *If you were asked to choose between living under the customary laws from the cultural practices of your people and statutory laws made by the national government, which would you prefer?* Indicator: $\mathbb{1}$(Prefer customary laws OR Prefer combined system).
- 75B-LIB. *In your experience, how often do violent conflicts arise over land ownership and distribution in Liberia?* Indicator: $\mathbb{1}$(All the time OR Often).

Figure 4 plots differences for these indicator variables among respondents on the County vs. Hinterland sides of the institutional boundary.

C.11 Cross-sectional Differences in Agro-Climatic Variables

Figure A.12 shows the differences (after accounting for district-level differences using fixed effects) in these agro-climatic variables at different bandwidths. Within forty kilometers of the institutional boundary: the average temperature is identical, altitude differs by less than 100 meters, and precipitation differs by less than 50 centimeters. Guan et al. (2015) suggest that differences in total annual rainfall of this magnitude have little effect on crop yields in West Africa. We also looked at raster data on soil type and fertility, and there is no change in soil attributes around the institutional boundary.

Figure A.12: Average Differences in Agro-Climatic Conditions by Bandwidth

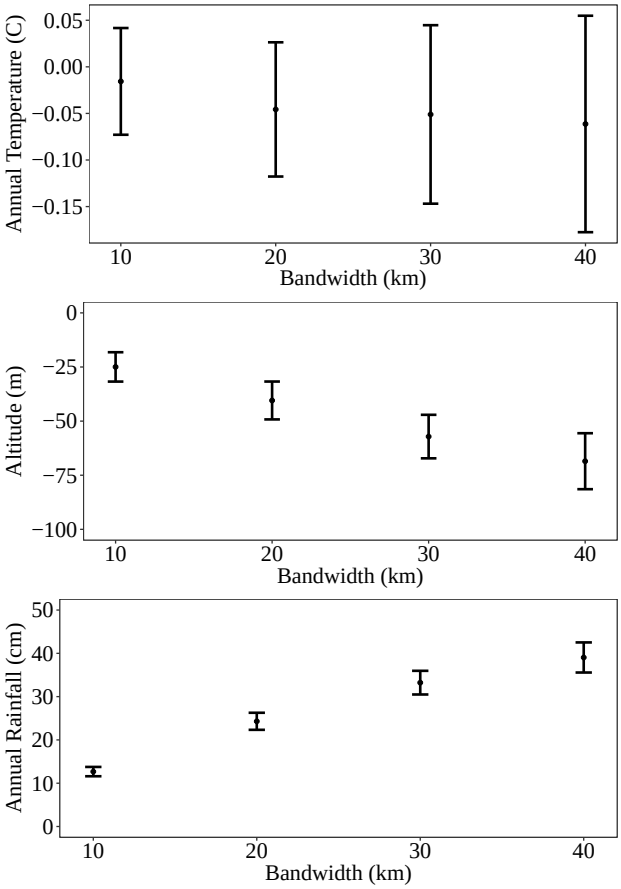


Figure A.12: we restrict attention to observations in our 40-km bandwidth and residualize variables by county. We then plot the difference in means (95% confidence intervals) between the County Area and Hinterland; standard errors are clustered on district. Outcome data comes from Hijmans et al. (2005), who provide gridded data a 1 km resolution.

C.12 Cross-sectional Differences in Ethnic Composition

The Afrobarometer provides three survey waves from Liberia: rounds 4 (2008), 5 (2012), and 6 (2015). Pooling across waves, the sample includes 3,598 respondents across 450 enumeration areas. We extract two sets of questions from the Afrobarometer. First, the round 4 survey fortuitously included several questions about traditional leadership and land that we use to assess cross-sectional differences in attitudes among respondents living on either side of the institutional boundary. Figure A.11 maps the 111 enumeration areas from round 4, indicating the enumeration areas we retain which fall within 40 kilometers of the institutional boundary. Second, the Afrobarometer asks what tribe or ethnic group respondents identify with. Aggregating across waves, Figure A.13 plots the proportion of individuals on each side of the institutional boundary (but within the 40-kilometer bandwidth) that identify with different ethnic groups. The Kpelle and Bassa represent just under 60 percent of the sample on both sides of the boundary. We see some divergence among the smaller groups, though none except the Gola make up even 10 percent of the sample on either side of the institutional boundary.

Figure A.13: Ethnic Composition of Afrobarometer Enumeration Areas

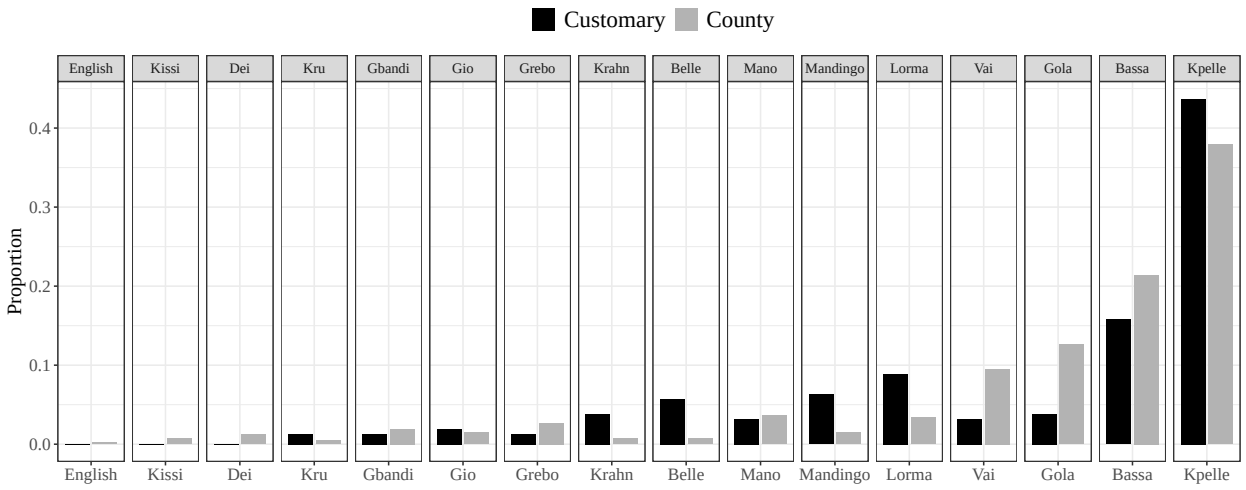


Figure A.13: proportion of respondents within 40 kilometers of the institutional boundary on the County and Hinterland sides of the institutional boundary. We stack respondents from rounds 4 (2008), 5 (2012), and 6 (2015) but exclude the southern counties.

Appendix References

Akpan, M. B. 1973. "Black Imperialism: Americo-Liberian Rule over the African Peoples of Liberia, 1841-1964". *Canadian Journal of African Studies / Revue Canadienne des Études Africaines* 7 (2): 217–236.

Angrist, Joshua D, and Jörn-Steffen Pischke. 2009. *Mostly harmless econometrics: An empiricist's companion*. Princeton University Press.

Bruce, John. 2008. *Land Tenure in Post Conflict Liberia*.

Calonico, Sebastian, Matias D. Cattaneo, and Rocio Titiunik. 2014. "Robust Nonparametric Confidence Intervals for Regression–Discontinuity Designs". *Econometrica* 82 (6): 2295–2326.

Guan, Kaiyu, et al. 2015. "What aspects of future rainfall changes matter for crop yields in West Africa?" *Geophysical Research Letters* 42 (19): 8001–8010.

Hijmans, Robert J, et al. 2005. "Very high resolution interpolated climate surfaces for global land areas". *International Journal of Climatology* 25 (15): 1965–1978.

Laughon, Samuel W. 1941. "Administrative Problems in Maryland in Liberia-1836-1851". *The Journal of Negro History* 26 (3): 325–364.

Lee, Alexander, and Kenneth A Schultz. 2012. "Comparing British and French Colonial Legacies: A Discontinuity Analysis of Cameroon". *Quarterly Journal of Political Science* 7 (4): 365–410.

Mattingly, Daniel C. 2017. "Colonial Legacies and State Institutions in China". *Comparative Political Studies* 50 (4): 434–463.

Rivard, Benoit. 2016. *Consulting Services Contract For the Development of A National REDD+ Strategy for Liberia*.

Unruh, Jon D. 2008. "Catalyzing the Socio-Legal Space for Armed Conflict: Land and Legal Pluralism in Pre-War Liberia". *Journal of Legal Pluralism*: 1–31.