Droughts, Land Appropriation, and Rebel Violence in the Developing World

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Scholars note that rebel atrocities against civilians often arise within rural areas in the developing world. This characterization is not far-fetched, and recent data show that rebel atrocities do predominately occur within rural agricultural regions. Yet the frequency of such incidents also varies substantially across different agricultural regions and years. What accounts for this observed variation in rebel-perpetrated atrocities against civilians within agricultural areas in developing countries? We develop a formal model to address this question, which contends that severe droughts can decrease food availability, prompting civilians to allocate food for immediate consumption and become increasingly willing to defend their diminishing supplies against rebels. This leads rebels to preempt the civilians' defensive efforts by committing atrocities, which forcibly separate civilians from their lands and food stockpiles. In empirically testing this hypothesis at the subnational level across the developing world, we find robust support for our game-theoretic model's predictions.

The killing of civilians by armed combatants—which when done intentionally for political motives we term "atrocities"—is widely considered to be one of the most pernicious attributes of modern warfare. It is therefore not surprising that researchers have extensively analyzed the potential determinants of this violence within the context of civil conflicts (e.g., Azam and Hoeffler 2002; Fjelde and Hultman 2014; Kalyvas 2006; Wood 2010). Building upon this body of research, our paper focuses on one key mechanism that we believe may drive rebel groups to perpetrate violence against civilians within rural regions across the developing world: severe droughts. Understanding these dynamics is important given that micro-level evidence (presented below) reveals that atrocities are often committed by rebel groups in rural regions where local food production is more susceptible to the negative effects of drought.

Scholars of rebel violence have used a variety of different approaches to evaluate their theories, including country-year or conflict-year data (Azam and Hoeffler 2002; Eck and Hultman 2007), carefully designed case studies (e.g., Kalyvas 2006; Weinstein 2007), and grid-cell data from Africa (Fjelde and Hultman 2014; Wood and Sullivan 2015). Yet, despite these important contributions, the effect of food production shocks on rebel groups' strategic incentives to victimize civilians has not been carefully analyzed. This is surprising as empirical evidence suggests that rebel violence against civilians tends to concentrate not only in rural areas, as current theories might predict, but specifically in areas that produce food for proximate consumption. Indeed, a close examination of a global sample of newly released data on rebel atrocities at the disaggregated within-country "grid-cell year" level (PITF 2009),[1] which also includes rebel atrocities in locations not currently

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1. That is, "cells" of approximately 55 km × 55 km around the equator (Tollefsen et al. 2012).

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experiencing active fighting between rebels and government forces, reveals two intriguing details that current theories of rebel violence do not adequately explain. Rebel-perpetrated atrocities in the developing world (i) predominately arise not only in rural regions but in agricultural areas specifically (99.6% of all incidents) and (ii) often occur during periods that do not experience active fighting between rebels and government forces within these same agricultural regions (26.4% of all incidents). This evidence suggests that a critical component is missing from our understanding of strategic rebel violence: rebel groups' reliance upon local agricultural resources for their operations and survival. Anecdotal evidence supports this interpretation. For instance, Naxalite rebels in the Bastar, India, used violence to expropriate food supplies from the local population during 2004, a year with exceptionally low food production, but did not do so in other years with more abundant food production (Gregory 2013; Singh 2006). We argue that this spatiotemporal variation in atrocities is a symptom of one specific, yet understudied, incentive for rebel violence: guaranteeing food security in response to food production shocks.

More specifically, the global grid-cell variation and anecdotal examples discussed above lead to two important and related questions explored here: What drives rebel groups to commit atrocities against civilians as a result of food security concerns in agricultural regions? More broadly, what accounts for the observed variation in the frequency of atrocities committed by rebels across agricultural areas in developing countries? To answer these questions, we develop a game-theoretic model that analyzes strategic interaction between two players: (i) a rebel group and (ii) a group of civilians that reside and work in a region where agricultural (food) production is the main source of income and sustenance. This model thus examines an important dynamic that to our knowledge has not received sufficient attention in extant research, namely, the "strategic competition" over croplands between the rebel group and civilians who farm the land to produce food.

We explain rebel violence against civilians by modeling atrocities as a rationally employed "eviction strategy" under the straining conditions of drought. Treating drought as a causal mechanism for violence has a precedent in studies of conflict (e.g., Burke et al. 2009) but has not yet been applied to the empirical study of atrocities. Building on this premise, we examine how severe droughts, which have substantial negative effects on cropland production in developing countries where they commonly occur, affect the strategic calculi of both (i) rebels and (ii) the civilian population. Our formal model posits that severe droughts diminish agricultural resources, which in turn increases the rebels' incentives to seize food resources as well as the civilians' incentives to defend their dwindling food supplies. In equilibrium, the rebels expect that over time seizing agricultural resources may become too costly. This compels them to preempt defensive efforts by using atrocities as a strategy to forcibly evict the civilians from their homes and croplands, as atrocities compel civilians to flee their lands or otherwise give up agricultural resources. We broadly evaluate these expectations by examining agricultural production and violence in Thailand and India and then empirically validate these contentions using spatially disaggregated atrocities data for the entire developing world.

Our focus on strategic interaction between rebels and civilians during times of drought makes several contributions to the literature. First, our formal model explains why rebels in developing countries often commit atrocities against civilians not only in the countryside—as current theories (e.g., Kalyvas 2006; Weinstein 2007) may predict—but specifically in "croplands," where agriculture (i.e., food production) is the main source of income and consumption. In treating cropland as a vital natural resource, we uncover an important mechanism that explains why violence against civilians is more likely in the countryside: production and consumption of agricultural produce. This treatment of cropland as a natural resource is consistent with Wood's findings that some rebels "engage in violence against civilians . . . to acquire necessary resources and prevent collaboration with government forces" (2010, 612); and with Weinstein's contention that violence may occur "where groups lack economic endowments, [and] rebel leaders can promise to provide private rewards expecting that the group will gain access to material resources at some point" (2005, 605). Our drought-based theory also relates to research showing that asymmetric reductions in rebel capabilities, for example, via military interventions (Wood, Kathman, and Gent 2012), lead rebels to pursue violence against civilians; to Hultman's (2007) finding that battlefield losses compel rebels to commit violence against civilians; and finally to past characterizations of atrocities as arising due to civilians' control over agricultural lands and the disconnect that this causes between these civilians and invading rebel movements (Mkandawire 2002).

Finally, our subnational developing country assessment of the above claims demonstrates that food-resources-related rebel atrocities are not only confined to African countries—which are the primary focus of current spatially disaggregated studies of atrocities (Azam and Hoeffler 2002; Fjelde and Hultman 2014; Wood and Sullivan 2015)[2]—but also occur with alarming regularity in developing states in Asia,

2. Note that a number of insightful nonspatially disaggregated global studies of atrocities do exist (e.g., Valentino, Huth, and Balch-Lindsay 2004; Wood 2010; Wood and Kathman 2013).

the Middle East, and Latin America. Hence, this paper advances the study of rebel-perpetrated atrocities by highlighting a crucial, yet understudied, dynamic of violence and by assessing its effect on a spatially disaggregated global sample.

BACKGROUND DISCUSSION

Numerous studies highlight the negative effects of drought on consumption in developing countries (e.g., Cutler 1986; Roncoli, Ingram, and Kirshen 2001). This change in consumption habits, alongside civilians' (Burke et al. 2009) and rebels' (Henk and Rupiya 2001) reliance on locally produced food,[3] suggests that there will be increased competition over these resources. With developing country croplands expected to experience the worst of global warming's drought-associated effects (Burke et al. 2009; Vidal 2013), our central question is thus: when will strategic interactions related to the use of cropland for food consumption between rebels and civilians in developing countries induce rebels to commit atrocities? To answer this question, our model assumes that rebels and civilians interact in rural cropland regions and that both players (i) value this cropland for consumption and (ii) must account for the effect of possible negative shocks such as a severe drought on this cropland.

These very features have been observed in the Horn of Africa, where structural constraints on farmers' and pastoralists' capital stocks, when combined with droughts, have generated increased risks of widespread violence, social breakdown, and formations of self-defense groups (Mkutu 2001). Droughts also intensified competition over agricultural output and croplands between farmers and rebel groups like the Naxalites, Janashakti, and Agami Yug in India (Gregory 2013; Singh 2006) and the Barisan Revolusi Nasional-Coordinate [BRN-C] in Thailand (Davis 2005; Srirai 2008). Further, these dynamics often lead rebels to perpetrate atrocities in these agricultural regions (Singh 2006; Srirai 2008).

The above examples highlight how violent interactions between civilian farmers and rebel groups often unfold. With the onset of drought, rebel groups are driven to expropriate the land of local civilian farmers to obtain the output stored on these lands and assure a steady supply of food. In anticipation of this, the farmers can form self-defense militias, as happened, for instance, in India (Singh 2006), Somalia (Hansen 2013), Sierra Leone (Keen 2005), Uganda (Mkutu 2001), and Peru (Gitlitz and Rojas 1983). Aware of this possibility, the rebels have increased incentives to prevent militia formation and to facilitate expropriation using violence (Singh 2006; Srirai 2008). Our model illustrates how these dynamics lead to atrocities against civilians during severe droughts.

The idea that rebels strategically commit atrocities against civilians to attain specific goals is well established in extant studies (e.g., Fjelde and Hultman 2014; Kalyvas 2006; Salehyan, Siroky, and Wood 2014; Weinstein 2007; Wood 2010).[4] We contend that securing sustenance in the face of sudden scarcity is one goal that justifies such violent means. Our model further shows that atrocities perpetrated by rebels are most likely in rural regions where the government's security presence is negligible (e.g., Kalyvas 2006; Mkandawire 2002), especially considering that, as Hendrix and Brinkman (2013, 4) note, "rebel movements typically do not grow their own food and depend on voluntary or *coerced contributions* from the population" (emphasis added). The rebels' strategy of expropriating civilians' arable land for the purpose of consumption, and civilians' strategy of defending their land, leads to a "contest" over the latter's agricultural property in our game model. We show that drought intensifies this contest, inducing rebels to use atrocities to maximize their chances of successful land grabbing. This competition can be especially pronounced if rebel groups move into areas where they do not enjoy traditional authority. In these cases, as Mkandawire argues, "having little in common with the peasantry, and nothing to offer it, they resort to violence as the only way to control it" (2002, 181). We confirm these dynamics below in demonstrating that, to deter civilians from forming defense militias and thus increase the probability of successfully evicting the civilians expropriating their croplands, the rebels are more likely to resort to atrocities during periods of severe drought.[5]

Our broader argument is also consistent with studies that emphasize the importance of "greed" within civil conflicts, especially the contention that armed actors might use violence to secure valuable resources (e.g., Azam and Hoeffler 2002; Wood 2010). For instance, rebels in Somalia and Burundi have expropriated agricultural land from local farmers both for consumption and as a "reward" to attract volunteers (Hansen 2013). Our model highlights the resource-based motivations of agents, specifically rebels and civilians, to secure sustenance during droughts, focusing on food access as a mediating factor as suggested by past research (e.g., Theisen, Gleditsch, and Buhaug 2013). Assuming that "every rebel movement aspires to some form of sedentary existence

3. Which is especially likely in developing countries where the infrastructure in rural areas may be frail.

4. While some studies focus on atrocities perpetrated by state actors (e.g., Koren 2014; Valentino et al. 2004), analyzing state-led atrocities is beyond the scope of this paper.

5. We provide additional anecdotal evidence of these dynamics in the appendix.

or respite in 'liberated zones'" (Mkandawire 2002, 200), we hypothesize that the opportunity costs of migration in response to drought are typically high and entail abandoning stockpiled food or switching from cattle to other forms of livestock that are more transportable across long distances. Rebel groups might thus prefer to operate locally and supplement their dwindling stocks by extracting additional supplies from the local population, especially as the value of crop stocks rises.

THE MODEL

Assume two players who interact in the rural area of a developing country: a rebel group r (that consists of group members) and a set of rural civilians b (i.e., workers)[6] who work as agricultural labor. The rural civilian laborers b work on their land L to cultivate crops—L is hereafter labeled as cropland—to produce food for consumption. "Total production of food" comes from the constant elasticity of substitution (CES) production function $\pi(L, b, K) = [\gamma(\alpha L^\rho + (1-\alpha)b^\rho + \beta K^\rho)^{1/\rho}]$[7] which includes three factors of production: cropland L, physical capital K (farm machinery, plows, houses where crops are stored), and rural civilian labor b. In this CES function, $\alpha \in [0, 1]$ is the relative weight of production inputs cropland L and labor b; $\beta \in [0, 1]$ is the weight attached to capital K; $\rho \leq 1$ is the elasticity of substitution; and $\gamma > 0$ the productivity parameter. Let $\phi \in \{0, 1\}$ be the incidence of drought where $\phi = 1$ denotes severe drought; hence the remaining share of cropland the civilians use for production and consumption when drought occurs is $(1-\phi)L$. The marginal productivity of this remaining cropland is $(1-\phi)\pi(L, b, K)$. The rate at which the civilian workers stockpile agricultural produce (i.e., food) generated from their remaining cropland for consumption is s. The total cropland produce stockpiled by b for consumption is thus $s(1-\phi)\pi(L, b, K)$.

The rebels r seek to expropriate the civilians' cropland L to (i) gain access to the agricultural produce (for consumption)[8] that the civilians b store/hide in houses located on the cropland and (ii) control the cropland. Expropriating and controlling L also gives the rebels access to the civilians' b labor. The rebels' r decision of whether or not to keep the workers on their cropland during a drought is crucial as they are aware ex ante that the civilians may oppose r's goal of expropriating and controlling L. Thus, as anecdotal evidence suggests, the rebels may strategically employ atrocities a (e.g., killings) against the civilian workers b to forcibly expropriate their cropland, while the civilians may form a militia m of forces drawn from b to defend against expropriation and potential atrocities. Let p be the probability with which the civilian labor b successfully defend against r. Given m and a, we let p follow a standard "contest success function," $p = [m/(m + a)]$ (e.g., Skaperdas 1996). The probability with which the rebels (civilians) successfully (fail to) expropriate (defend) the rural civilians' (their) cropland is $(1-p) = 1 - [m/(m + a)]$.

Let f_r be the rebel group's financial resources used for different activities, including expropriation. If r succeeds in expropriating the civilians' cropland with probability $(1-p)$, they obtain the benefit $s(1-\phi)\pi(L, b, K)$ as controlling L provides r with access to b and the stockpiled food located on L. The rebels incur costs ac_r for committing atrocities a.[9] The rebels' costs of retaining the workers b on the expropriated cropland is given by the convex function $c_r((1/2)\theta b^2)$, where $\theta > 0$ is the weight r places on the costs of retaining b.[10] The rebel group's total cost is thus $c_r(a + (1/2)\theta b^2)$ and their net utility function is

$$u_r = f_r - c_r(a + \frac{1}{2}\theta b^2) + (1-p)[s(1-\phi)\pi(L, b, K)]. \quad (1)$$

The rebel group's optimization problem is to maximize (1) with respect to a subject to the constraint $c_r(a + (1/2)\theta b^2) \leq f_r$. Let mc_b be the civilian workers' costs of forming a self-defense militia m. f_b is the civilians' financial resources used for food production. The expression $s(1-\phi)\pi(L, b, K)$ is the total cropland output stockpiled for consumption. Since the civilians successfully defend their cropland from r with probability $p = m/(m + b)$, their net utility function is

$$u_b = f_b - mc_b + p[s(1-\phi)\pi(L, b, K)]. \quad (2)$$

The rural civilians' optimization problem is to maximize (2) with respect to m, subject to $mc_b \leq f_b$. The sequence of

6. The rebel group is fully denoted as r_j where $j = \{1, 2, 3 \ldots m\}$ and the rural civilian workers as b_i where $i = \{1, 2, 3 \ldots n\}$; subscripts i and j are suppressed for notational convenience. Given our theoretical goals, we focus on strategic interaction between r_j and b_i ("r and b") the rebels and civilians working on the cropland.

7. Developed by Arrow et al. (1961). This CES function is described further in the appendix.

8. Conversely, if r chooses to migrate to other areas when $\phi = 1$, then r is likely to move away from the local cropland L, reducing their prospects of expropriating and gaining access to food stockpiles. Migration is thus a risky strategy for r, who need the stockpiled food on L for consumption when $\phi = 1$.

9. This includes operational costs (e.g., mobilization costs of recruiting individuals) to carry out atrocities.

10. That is, the costs of keeping the workers as bonded or regular wage-earning workers.

play, influenced by the examples of rebel group–rural civilian interaction discussed below, is as follows. A severe drought ϕ occurs that is observed by r and b. Having observed ϕ, the civilians stockpile food s from their surviving cropland for consumption. The rebels then choose whether or not to expropriate the civilians' cropland using atrocities a given ϕ, while the civilians choose m given r's choice of a. The players' actions influence p and $(1 - p)$ and, subsequently, their realized payoff.

Equilibrium result and comparative statics

Lemma 1. In the subgame perfect Nash equilibrium of the game between r and b, the optimal agricultural produce (food) generated from the cropland L and stockpiled by the rural civilian labor b for consumption is

$$s^* = \frac{f_r}{(1-\phi)\gamma(\alpha L^\rho + (1-\alpha)b^\rho + K^\rho)^{\frac{1}{\rho}}}.$$

The optimal militia size b can form for defense against the rebels r is

$$m^* = \frac{s(\phi(L+K) - \phi b]^2)}{4a(1+\phi)},$$

while the marginal productivity of b working on L is $(1-\phi)[\gamma(\alpha L^\rho + (1-\alpha)b^\rho + K^\rho)^{(1/\rho)-1}](1-\alpha)b^{\rho-1}$. The optimal atrocities level committed by r is $a^* = \sqrt{(m/\phi)s(\phi(L+K) - \phi b]^2)} - (m/\phi)$.

The formal proof of lemma 1 is provided in the appendix, available online. Two sets of comparative static results derived from the subgame-perfect Nash equilibrium in lemma 1 explain when and why the rebel group will commit atrocities against the workers b. The first set of comparative static results are:

Proposition 1. When severe drought occurs ($\phi = 1$), (i) the rural civilian labor will stockpile in equilibrium agricultural output $s^* > 0$ from their cropland for consumption and (ii) the rebels' strictly dominant strategy is to expropriate the civilians' cropland.

The logic behind proposition 1 (the propositions' formal proof is in the appendix) that provides the foundation for proposition 2's prediction (stated below) is as follows. First note that when severe drought occurs ($\phi = 1$), it adversely affects the civilians' consumption habits (formally proven in "proof of claim 1" in the appendix). The civilians compensate for this adverse effect by stockpiling food $s^* > 0$ generated from their surviving arable cropland (proposition 1, part i); this action ($s^* > 0$) is common knowledge to all the players. In response, the rebels r seek to expropriate the civilians' remaining arable cropland if $s^* > 0$ to gain direct access to s^*, since the stockpiled food is located on the cropland itself. Indeed, the opportunity to gain direct access to s^* is a powerful motivation to expropriate the cropland, as the rebels require the food stockpiled on L for their own immediate consumption in a drought.[11]

Further, expropriating the civilians' cropland allows the rebels not only to control the physical source of the stockpiled food but also the surviving arable cropland. Controlling this land is crucial; it facilitates continuous access to the gathered food s^* for r and, as a result, helps the rebels to maintain their consumption levels during a drought and secure a steady supply of stockpiled food. This allows r's leaders to make credible promises to group members about their ability to obtain and (re)distribute the stockpiled food (see "proof of claim 2," appendix), which helps recruitment and fosters cohesion within r. Finally, a severe drought intensifies competition between the civilians and the rebels over consuming s^* and sharply curtails r and b's incentives to share consumption of s^*, now a significantly limited finite resource. Such competition reinforces the rebels' need to control the cropland to exploit the civilians' land for their own consumption. It also ensures that cropland expropriation emerges as a strictly dominant—and cooperation with the civilians over sharing s^* strictly dominated—strategy for r when $\phi = 1$ (proposition 1, part ii).

Statistically evaluating our claim that rebels choose to expropriate croplands during droughts is difficult, because (to our knowledge) no cross-national data on food stockpiling and agricultural expropriation is publicly available. Yet the following examples described in detail in the appendix reveal the plausibility of these claims. Consider Bastar and Dantewada—agricultural districts in Chattisgarh, India, where rice is the predominant crop—where Naxalite rebels actively operate (Pandita 2011; Singh 2006). When a severe drought struck Bastar and Dantewada in 2004, villagers in these two districts "accumulated rice in numerous *anaj ghars* located on their rice fields" (Singh 2006, 71). As predicted by our theory, this induced the Naxalites to expropriate the villa-

11. Conversely, transporting the stockpiled food from the cropland to another location imposes transaction costs on the rebels and also increases the possibility that the food may spoil during the process. This further incentivizes the rebels to obtain and consume stockpiled food.

gers' rice fields to get food for sustenance and to feed the rank and file of their group,[12] and to ensure a steady food supply given uncertainty created by the drought (Gregory 2013). In Somalia, civilians in Lower Juba's rural agricultural region gathered and hid (in houses) food for consumption when this region was affected by a drought in 2011; this invited land-grabbing attempts by Al Shabaab rebels (Hansen 2013). Further, in the Songkhla province of Thailand—where rice is the predominantly cultivated crop—a comparable rebel group, the Barisan Revolusi Nasional-Coordinate (BRN-C), operates. During the intense drought of 2004, farmers working in the rice-producing areas of Rattaphum, Na Mom, and Bang Klam in Songkhla stored significant amounts of rice on their rice fields for future consumption (Rattanachaya 2004, 47–48; Srirai 2008). This influenced the BRN-C to decide to raid and capture rice fields in Rattaphum, Na Mom, and Bang Klam to acquire, distribute among group members, and eat rice stored by farmers in the rice fields (Rattanachaya 2004; Srirai 2008).

To provide more systematic quantitative evidence for the link between droughts and rebel land expropriation we geocoded data on rainfall and agricultural land expropriation by rebels at the district level in India and the province level in Thailand. In India, rebel groups such as the Naxalites, Agami Yug, and Janashakti operate across the following seven states (where cropland expropriation and killing of civilians by rebels occur): Andhra Pradesh, Bihar, Chattisgargh, Jharkand, Madhya Pradesh, Orissa, and West Bengal. As discussed in the appendix, we use these data to assess the link between severe drought and expropriation of cropland by rebels in 58 agricultural districts within the aforementioned seven Indian states between 2002 and 2009 (the years for which data were available) where rice, *bajra*, and *kharif* are produced for consumption (NREGA 2010). Analysis of this district-year sample (see appendix) reveals that severe droughts significantly increased the extent of agricultural property expropriation by rebels in India during 2002–9. These results are statistically significant, substantively sizable, and robust to many model specifications, including penalized maximum likelihood estimation.

We conducted a similar analysis for Thailand. Studies on rebel violence show that over 90% of the civilians killed by rebel groups (e.g., the Pattani United Liberation Organization and BRN-C) in rural areas resided in 18 provinces (plotted and listed in the appendix) (Davis 2005; Helbardt 2011). These provinces produce 80% of Thailand's five key crops: rice, sugarcane, rubber, corn, and maize.[13] Correspondingly, we geocoded data on rainfall, cropland expropriation by rebels, and other key indicators for each of these 18 Thai provinces from 2004 to 2010. As described in the appendix, statistical analysis from the Thailand province-year data reveals that the impact of drought on land expropriation by rebels in our Thailand province-year sample is again positive and statistically significant across many model specifications. Thus, our Thailand and India analysis, and anecdotal evidence, suggest that our argument that rebels expropriate agricultural land from civilians during severe droughts is plausible.

Yet note that in equilibrium the rebels recognize ex ante that when $\phi = 1$ they face a significant trade-off ex post in respect to expropriation. On the one hand, they can peacefully co-opt or capture the civilian workers b and use them as labor for agricultural production on these expropriated croplands. But retaining the workers b on L will compel r to share the food stockpiles with b, at least up to the amount necessary for survival. On the other hand, the rebels can expel these civilian workers from their land and consume the stockpiled food without sharing it. Our model suggests that when severe drought occurs, the rebels address this trade-off by choosing not to employ the civilians for agricultural production, expelling (i.e., evicting) them from the cropland instead. Further, as shown in proposition 2, r will strategically employ atrocities against the civilians to evict them from L during a drought. Before proceeding to proposition 2, however, we present three comparative statics derived from lemma 1 to explain why the rebels will evict the civilian workers from L when $\phi = 1$.

First, during a severe drought, the civilian workers' productivity exhibits sharp diminishing marginal returns ($\pi_b < 0$, $\pi_{bb} < 0$ for $\phi = 1$). The rebels thus understand a priori that their returns from keeping these workers on the expropriated croplands is negative in this context.[14] This is hardly surprising. Severe droughts erode the workers' physical ability to work owing to water shortages, which reduces their capacity to work in the fields. Based on this formal result, we argue that labor's declining productivity during droughts is a key reason for why rebels would not keep workers on the expropriated cropland, but instead evict them. Second, comparative statics show that during a severe drought, the finite stockpiled food s^* available post-expropriation will shrink rapidly if the civilian workers stay on the expropriated cropland, because both the rebels and civilians will consume it (see appendix for proof of this claim). Hence the presence of civilians on the expropriated croplands substantially exacerbates population pressures with respect to consumption

12. Ministry of Home Affairs (2005, 39–40).

13. See National-Statistics-Office (1985). This source is listed in the appendix.

14. See the appendix for formal proof of this claim.

of the finite stockpiled food during a drought, thus prompting "food insecurity" (Urdal 2008; Wischnath and Buhaug 2014). Such population pressures on limited food supplies during droughts engender more uncertainty about food consumption, which further incentivizes the rebels to evict the civilians from their cropland to ensure that there are fewer civilians to feed and thus more food available for r to consume (see appendix for proof of this claim).

Third, comparative statics show that the civilians recognize that the rebels cannot credibly commit to not forcibly seize b's cropland L and evict workers from L when $\phi = 1$ as r's incentives to do so are common knowledge. This encourages the civilians to form a militia m to defend their agricultural land from confiscation by r (rather than cooperate with the rebel group), as expropriation and eviction by r will deprive the civilians from consuming food stockpiles on L. Hence, the workers b cannot credibly commit not to form a militia. Correspondingly, the rebels recognize that if the civilians form a sizable militia to defend their stockpiled food and cropland from r,[15] then r's costs from seizing and exploiting the civilians' cropland for food consumption will rise substantially and become prohibitive (see appendix for proof of this claim). Thus the rebels will have additional incentives to forcibly evict the civilian workers from their cropland L as these workers cannot form a militia to oppose r when they are forced to flee from L.

Historical evidence from the 2004 drought in the rice fields of Bastar and Dantewada (in India) and Songkhla in Thailand corroborate these three comparative static claims. For instance, India's Home Ministry reported that after the monsoon failed in 2004, farmers and *adivasis* residing in Bastar and Dantewada discussed formation of defense groups to defend their agricultural land from being raided by the Naxalites.[16] As described in detail in the appendix, the Naxalite rebels believed that if the farmers in these two districts formed self-defense militias, then these farmers would make it difficult for the Naxalites to get access to the peasants' rice fields and crops stored in *anaj ghars*, to militarily challenge them, and would deprive the Naxals of food for consumption during the drought (Pandita 2011; Singh 2006, 31–32).[17] The Naxalites in Bastar and Dantewada thus took the "critical decision" of expelling the peasants and *adivasis* from their farmlands so that the farmers could not hinder their appropriation goals (Shankar 2006; Singh 2006).[18] This eviction decision was further reinforced by their belief that owing to the drought the farmers would be an unproductive workforce who would not add much to crop production (Pandita 2011; Singh 2006).

Similarly, researchers and media sources suggest that farmers in Rattaphum, Na Mom, and Bang Klam in Songkhla (Thailand) during the 2004 drought discussed among themselves putting together defense associations (Chongkittavorn 2004, 17) to deter the BRN-C from appropriating their rice fields. The BRN-C felt that such self-defense militias would seriously impede their goal of capturing and controlling rice fields in Rattaphum, Na Mom, and Bang Klam (see Chongkittavorn 2004) situated in Songkhla (see appendix for more details). The BRN-C leaders also viewed the continued presence of farmers in the rice fields of Songkhla province as a financial liability given their diminished capacity to work because of water scarcity (Srirar 2008, 21) resulting from the failed 2004 monsoon (Janchitfah 2004; Rattanachaya 2004; Srirai 2008). The BRN-C's view of farmers as a liability and threat to their land-grabbing goals influenced them to expel the peasants from the rice fields of Rattaphum, Na Mom, and Bang Klam (Srirai 2008), which they sought to appropriate (Janchitfah 2004; Srirai 2008). Farmers also sought to form self-defense groups to protect their agricultural land from rebels during intense droughts—which induced local rebels to seek to evict these farmers—in Lower Jubba (Somalia) during the 2011 drought (Hansen 2013) and in Arequipa (southern Peru) in 1982 (Gitlitz and Rojas 1983).

Thus the preceding examples and comparative statics show that the declining productivity of labor, commitment problems between r and b, and the possibility that the civilian workers might form a militia to oppose r strongly encouraged the rebels to evict rather than retain the workers on the cropland when $\phi = 1$.[19] Eviction also accomplishes another goal for the rebels which further encourages them to expel the workers: it reduces the rebels' costs of confiscating the cropland L as the workers cannot undertake the necessary organizational effort to develop m to defend L when forced to flee. Given the rebels' rationale for evicting the civilians from L and the result in proposition 1, all of which arise when $\phi = 1$, the final set of comparative statics from our model (stated in proposition 2) suggests that during a severe drought, the rebels will commit atrocities against the civilians to facilitate eviction and increase the probability of successfully grabbing cropland and food supplies.

15. Meaning that m reaches an upper threshold level $\bar{m}$ (formally characterized in lemma 1's proof).

16. Ministry of Home Affairs, "Status Paper on the Naxal Problem," August 18, 2004, Internal Security Division. Government of India, New Delhi; also see Shankar (2006).

17. Ministry of Home Affairs, "Status Paper on the Naxal Problem," Internal Security Division. Government of India, New Delhi, 11–12.

18. Planning Commission of India, *Development Challenges in Extremist Affected Areas: Report of an Expert Group* (Government of India: New Delhi, 2008).

19. See the appendix for formal proof of this claim.

Proposition 2. During a severe drought ($\phi = 1$), the (i) equilibrium level of atrocities a^* committed by the rebel group r strictly increases and (ii) probability $(1 - p)$ with which r successfully seizes the civilian workers' cropland strictly increases for $a^* > 0$.

The intuition behind proposition 2 (the proposition's formal proof is in the appendix) is as follows. To start, recall that the finite food stockpiles s^* will shrink rapidly in a severe drought if the civilian workers b remain on the expropriated cropland L, as both b and r need to consume these stockpiles for survival. Hence if the civilian workers remain on L, then the available amount of stockpiled food obtained from L (post-expropriation) will be insufficient for basic sustenance required for survival by the rebel group, which r understands ex ante. As suggested by scholars, under severe drought conditions, insufficient crop stockpiles can engender and accentuate food insecurity and competition over finite food supplies between residents (civilian workers and the rebels in our case) in rural agricultural areas of developing states (Fjelde 2015, 527; Wischnath and Buhaug 2014). Building on this insight, our model suggests that such food insecurity and competition over finite food supplies encourages the rebels to not only evict the civilians b from L but also commit atrocities (during expropriation) against b—as these civilians are easy targets for predatory rebel groups—to facilitate eviction when $\phi = 1$ (proposition 2, part i). Three reasons derived from our model account for this claim.

The first reason is that killing civilian workers allows the rebels to reduce the number of civilians, thus helping r to curb population pressures on the finite stockpiled food resource. This ensures that the rebels can consume a greater share of the stockpiled food because a greater amount of s^* obtained from the cropland is available to r for consumption when the civilians are removed. The second reason is that killing the workers b allows the rebels to send a powerful observable signal to these workers that they (r) will not share the stockpiled food on L with b during the drought but rather evict b from the cropland. As such, the signal sent to the civilian workers during a severe drought—by r's strategy of increasing the frequency of atrocities against the workers—helps the rebels to generate fear among b. This fear influences the civilians to flee from their cropland, which facilitates the rebel group's goal of forcible eviction and land expropriation, including the stockpiled food on L.

Third, r recognizes that committing more atrocities against the civilians b will allow the rebels to credibly threaten the civilians' physical integrity in equilibrium. The threat is credible since the rebels' net utility from committing atrocities a is higher than their benefits from retaining the civilians b on L during a drought which is reinforced by the workers' declining productivity (see appendix for formal proof of this claim). The credibility of the threat produced by committing atrocities helps r to compel b to flee from their cropland, which makes it unlikely that the civilians will form a militia therein leading to a decrease in the possibility of m^*.[20] This increases the ex post probability $(1 - p)$ with which r successfully seizes the civilians' cropland (proposition 2, part ii) and fully captures the consumption benefits of the surviving arable land, thus providing the rebels with additional incentives ex ante to increase atrocities against civilians.

Anecdotal evidence gathered from Bastar and Dantewada (in Chattisgarh, India) and Songkhla (in Thailand) further bolster our theoretical claims. To this end, first note that a report issued by India's Home Ministry in 2005 pointed out that when the monsoon failed in 2004 in Chattisgarh over 1,000 people were killed by the Naxals in Bastar and over 3,000 houses were burned by the Naxalites circulate.[21] Another study also posited that the Naxalites in Bastar and Dantewada committed atrocities against civilians during the 2004 drought: "150,000 people have been displaced, approximately one-third of whom were officially living in camps as of February 2006; some 500 to 1000 people have been killed and over 3000 houses burnt" (Gregory 2013, 18). Further, results from our India district-year sample reveals (discussed below) that the outbreak of severe drought in rural croplands of India leads to a statistically positive increase in civilians killed by rebels (e.g., Naxalites) operating in these croplands.

Why did the Naxalites consistently carry out such indiscriminate acts of violence against farmers in Bastar and Dantewada during the 2004 drought? To answer this question, the print media and academics have suggested that during the 2004 drought, the Naxalites (as predicted by our theory) indiscriminately killed farmers living in Bastar and Dantewada in 2004 to prevent consumption of limited food by rural residents; indeed, the fewer farmers living on arable lands, the greater the amount of crops that the Naxals could consume.[22] Another goal the Naxalites hoped to achieve by massacring farmers and tribals in Bastar in the 2004 drought was—as also suggested by our theory—to send a clear mes-

20. That is $\partial m^{*} / \partial a < 0$ as shown in the proof of part i of proposition 2 in the appendix.

21. Ministry of Home Affairs, "Revisiting the Naxal Problem," July 14, 2005, Internal Security Division (Shastri Bhawan), Government of India, New Delhi, 3–4.

22. Shankar (2006, 91); also see "Maoist Shadow over Chhattisgarh," *Times of India*, May 16, 2005; Singh (2006).

sage to the local farmers[23] that they would be physically harmed if they did not leave their rice fields (Shankar 2006; Singh 2006); this meant that the Naxals were strategically using acts of murder and brutality against villagers to generate fear among the villagers as such fear would compel the villagers to run away from their rice fields (Shankar 2006, 59–60) and hide in neighboring forests (Pandita 2011; Singh 2006). Finally, we describe in more depth in the appendix that the Naxalites in Bastar and Dantewada during the 2004 drought also recognized that forcing the civilians to flee from their fields by killing these civilians would help them to capture the rice fields, obtain stored food for consumption, and make it impossible for the farmers to build defence organizations that could challenge (see Shankar 2006; Singh 2006) the Naxalites' land appropriation goals (Gregory 2013; Shankar 2006; Singh 2006).

Similarly, the BRN-C resorted to killing farmers in Rattaphum, Na Mom, and Bang Klam (in Songkhla) as a tactic to evict these farmers from their rice fields when the region suffered from a serious drought in 2004 (Chongkittavorn 2004; Rattanachaya 2004; Srirai 2008). In fact, the government of Thailand's Ministry of Interior report in 2005 points out that there was a sharp (almost 90%) increase in villagers killed in Songkhla during the drought of 2004 and moreover, beheading, hangings, and beatings of farmers in Songkhla became a frequent occurrence.[24] Some scholars also documented that during the 2004 drought in Songkhla the BRN-C killed over 1,000 farmers in Rattaphum, forcefully displaced them from their fields,[25] and captured grain stockpiles (Chongkittavorn 2004; Rattanachaya 2004). Statistical estimates from our Thailand province-year sample discussed later show that intense droughts in rural crop-producing regions lead to sharp increases in civilians killed by rebel groups in these regions.

Scholars and policy pundits in Thailand have suggested that the rampant killing of civilians in Songkhla during the 2004 drought was driven by strategic considerations. Indeed, as our theory predicts, the first objective behind the BRN-C-led killing of civilians in Songkhla in 2004 was to send a clear signal to the farmers that their presence in the rice fields would not be tolerated; thus murdering the villagers would produce a deep-rooted fear among farmers that their lives would be in danger if they remained on their farms.[26] Generating fear among farmers in Songkhla (by resorting to indiscriminate killings) to expel them from their farms was seen—as suggested by our theory and as described in the appendix—by the BRN-C commanders as a tactic to discourage farmers from forming associations to defend their farmland and crops [27] and their property (Davis 2005; Rattanachaya 2004). The BRN-C's second objective for killing farmers in Rattaphum, Na Mom, and Bang Klam in Songkhla was driven by the need to curtail the number of individuals who could consume the limited amount of rice stored by the farmers on their croplands in the 2004 drought (Chongkittavorn 2004; Davis 2005; Rattanachaya 2004). As suggested in an interview given by a captured BRN-C leader "Hama," the BRN-C killed farmers in Rattaphum, Na Mom, and Bang Klam to get them to leave their farms and prevent them from eating rice saved in *B̂ānk̄ĥāws* as the BRN-C wanted to consume this rice.[28]

Building on this detailed anecdotal evidence from Bastar, Dantewada, and Songkhla, we conducted a brief statistical analysis of rebel-perpetrated atrocities within both our aforementioned district-year data for India (2002–9) and province-year data for Thailand (2004–10) to evaluate key claims from our model. Our findings, discussed in full detail in the appendix, suggest a statistically significant positive association between severe droughts and rebel-perpetrated atrocities in these two cases. These results, and our model's predictions, suggest the following hypothesis, which is statistically evaluated below:

> **H1.** Within rural cropland areas of developing countries, severe droughts will be associated with an increased frequency of rebel-perpetrated atrocities against civilians.

EMPIRICAL ANALYSIS

Our hypothesis posits that drought-affected agricultural areas within developing countries will be more likely to experience rebel-perpetrated atrocities than will comparable areas that do not exhibit similar drought conditions. We test this hypothesis on a sample encompassing 14 years (1995–2008)[29]

23. Shankar (2006, 59). Also see Ministry of Home Affairs, "Revisiting the Naxal Problem," n. 26; Singh (2006).

24. Ministry of Interior, July 2005, *Civilians Attacked and Villages Raided by BRN-C in Songkhla in 2004* (Bangkok: Government of Thailand).

25. Davis (2005), Srirai (2008).

26. Ministry of Interior, July 2005, *Civilians Attacked and Villages Raided*, n. 32; also see Chongkittavorn (2004).

27. Chongkittavorn (2004, 12). Also see Janchitfah (2004), Srirai (2008).

28. Hama's interview was recorded and discussed in Ministry of Defense, March 2005, "Domestic Security Problems in Thailand," White Paper, Supreme Command Headquarters, Bangkok.

29. The total temporal range for which information on our variables was available.

and 138 developing countries.[30] These data are first structured into a cell-year level data set wherein cells—our cross-sectional unit of interest—are measured at the 0.5 × 0.5 decimal degree resolution[31] for our developing country land areas (Tollefsen, Strand, and Buhaug 2012). We then retain only those terrestrial cells that can be reasonably classified as pertaining to rural cropland areas. To achieve this, we first identify the extent of cropland within each of our developing country cells, as based upon the percentage of a cell's area whose land cover class was determined to be (irrigated and nonirrigated) cropland by the Globcover 2009 project's analysis of global satellite imagery data (Bontemps, Defourny, and Van Bogaert 2009), which are plotted for our developing country sample in figure 1. We then omit all cells that were identified as having zero cropland, thereby ensuring that the remaining cells in our developing country sample most closely correspond to the "rural/agricultural" context that is assumed by our formal model.[32] There are approximately 26,860 total cells observed for any given year within our 1995–2008 sample period, with the average developing country in our sample containing roughly 197 cropland cells.

The dependent variable, atrocities$_t$, is operationalized as the yearly (t) count of atrocities committed against civilians by insurgents within a sample cell. This measure was coded from the PITF Worldwide Atrocities Dataset, which defines atrocities as "implicitly or explicitly political, direct, and deliberate violent action resulting in the death of noncombatant civilians" (PITF 2009, 3). The PITF uses a primary set of eight international news and NGO sources[33] to collect and code a reasonably systematic sample of atrocities occurring worldwide, 1995–2014, and then uses human coders to accurately record each atrocity's geolocation. The resultant PITF data thereby limit the starting year for our sample to 1995. The PITF records information on both atrocities campaigns and atrocity incidents where five or more noncombatant deaths occurred,[34] and we focus on incidents to ensure comparability across cases, and to facilitate temporal aggregation. Given that our theory pertains to rebel perpetrators exclusively, we further limit our atrocity cases to atrocity incidents arising from perpetrators identified as members of nonstate organizations or groups with no allegations of state support—which correspond to roughly 33% of all atrocity incidents for our years of interest—and then sum each cell's identified atrocity incidents to the yearly level. There are 2,446 incidents in our 1995–2008 sample, with an average cell-year count, standard deviation, and range of 0.007, 0.207, and 0–60. Additional summary statistics, histograms, and spatio-temporal plots of atrocities$_t$ appear in the appendix. For our sample, a total of 75 countries experienced at least one rebel-perpetrated atrocity, underscoring our earlier contention that rebel-perpetrated atrocities are not limited to active civil wars.

Given the event count nature of atrocities$_t$, we employ a negative binomial (NB) model in our baseline specification below. In doing so, we are relaxing the (Poisson) mean-variance equality assumption so as to allow for a conditional variance in our observed counts that is larger than our count measure's conditional mean. The observed values for atrocities$_t$ lend support to this decision, as the variance of this measure (0.042) is far larger than the corresponding mean (0.007). However, there are also a disproportionate number of zero count observations in our sample, relative to positive atrocities$_t$ count values, with over 99% of all observations recording a zero value on atrocities$_t$. Given this feature, as well as the actuality that, for many cells, atrocities were highly improbable due to either a stringent rule of law, a harmony of interests, or an absence of any human presence, many of our sample zeroes are likely reflective of cell-years that could never have experienced atrocities under any circumstances, rather than count stage instances in which a rebel could have initiated an atrocity but chose not to do so. Ignoring this feature, and treating all zero observations as true count stage zeroes, risks biasing our estimates. To avoid these biases, we must statistically account for the mixture of excess zeroes that exist within atrocities$_t$.

We use a zero-inflated negative binomial (ZINB) model to do so. This approach draws upon recent studies that have recognized the potential for zero-inflated count processes within event counts of similar phenomena, including domestic conflicts arising within subnational units (e.g., Hegre, Ostby, and Raleigh 2009) and instances of violence against civilians measured at a comparable (PRIO-GRID) level of aggregation

30. We use the International Statistical Institute's threshold to identify our sample countries (ISI 2012). The developing countries included in our sample are listed in the appendix.

31. That is, cells of approximately 55 × 55 kilometers at the equator (3,025 square kilometer area).

32. Note that we (i) control for the extent of cropland within these remaining cells in our analysis and (ii) examine alternate "rural/agricultural" criteria in our robustness section, including samples of all developing country cells with little to no urban land (Bontemps et al. 2009).

33. Specifically, Agence France Presse, Associated Press, *New York Times*, Reuters, CNN, BBC World Monitor, All-Africa, and http://syrianshuhada.com/—though additional local and NGO/IGO sources can appear as primary or secondary sources in the PITF data when quoted by the aforementioned sources.

34. An incident is defined as "an atrocity perpetrated by members of a single organization or communal group, or by members of multiple organizations or groups reportedly acting in concert, in a single locality within a 24-hour period" (PITF 2009, 6), whereas campaigns correspond to a residual category for atrocities that lack sufficient information for the identification of incidents.

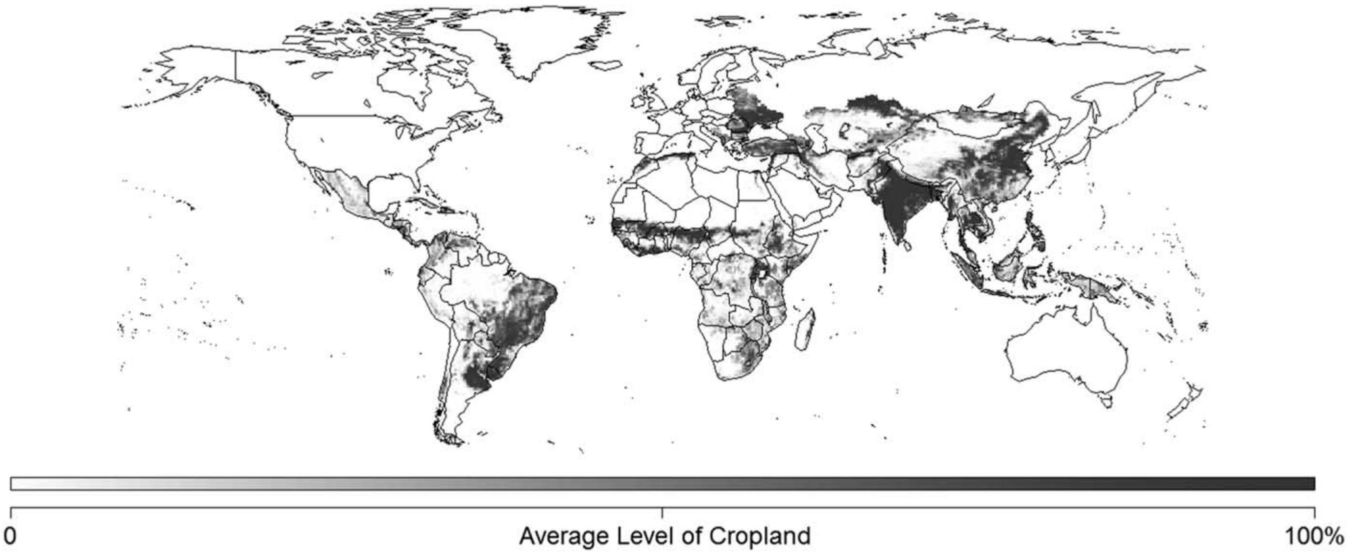

Figure 1. Cropland levels within developing country sample (1995–2008). A color version of the figure is available online.

to that used here (Fjelde and Hultman 2014). Accordingly, we build upon our baseline NB specification with a series of ZINB specifications. The latter models allow us to evaluate the effects of our covariates upon the very cases that are of most interest to the study at hand: cell-years that are potentially atrocity prone. The ZINB model specifically does so by combining the results from a binary logit equation testing for whether (or not) a zero observation is likely to have been produced by the zero-only data generating process (d.g.p.) with the results of a negative binomial count equation that tests for the effect of our covariates on the expected frequency of rebel-perpetrated atrocities_t, conditional on a case being nonzero inflated. We equate such a case in our application to a cell-year that is at least structurally able to experience an atrocity incident, which we can contrast with a cell devoid of any human presence or interaction due to climate and geographic factors, or with a cell that simply lacks the opportunity for atrocities due to (i) an absence of conflict-prone social conditions or (ii) a harmony of interests.

Recall that our hypothesis expects drought-affected areas in developing countries to experience higher frequencies of rebel-perpetrated atrocities than areas not affected by drought. We thus construct a binary independent variable—drought_t—that is measured at the same 0.5 × 0.5 cell resolution as our dependent variable, and merge this to our cell-year global grid sample. We operationalize drought_t using a standardized precipitation index (SPI) that aggregates monthly precipitation data to the cell-year level (Tollefsen et al. 2012). Using monthly rainfall deviations from the local norm, the SPI classifies various forms of dryness, including (i) moderate dryness (cell-years that saw at least three consecutive months of moderate dryness) and (ii) severe dryness (cell-years that saw at least two consecutive months of severe dryness). We follow existing conventions (Tollefsen et al. 2012) and classify a "severe" drought_t as one in which both conditions i and ii are met and code drought_t as 0 otherwise. We report summary statistics for drought_t in our appendix and evaluate additional operationalizations of drought in our robustness section.

In addition to drought_t, several cell-year level controls are added to the count stage of our NB and ZINB model specifications. These variables are derived from either the PRIO-GRID (Tollefsen et al. 2012) or from the PITF's atrocities data. We lag all time-varying political-economic controls (which could mediate the effects of droughts) by one year but maintain the current-year measures for our (largely time invariant and exogenous) geographic controls. Summary statistics for all control variables are listed in table A1 of the appendix. Several of our cell-level controls were included to ensure that any findings pertaining to drought_t are robust to proximate levels of conflict and social strife. Here we include cell-level one year lags of civil conflict_{t-1} presence, local ethnic diversity_{t-1},[35] and the spatial lag of atrocities_{t-1}. Our models also control for a cell's broader geographic characteristics by adding each cell's ln cell area_t, ln border distance_t, and the percentage of a cell's area denoted as urban and cropland (Bontemps et al. 2009), each of which is time invariant. We account for civilian population, as well as state penetration and economic wealth more generally, by controlling for each cell's ln population_{t-1}, travel time_t to the nearest major city (in logged minutes) and logged gross cell product (Nordhaus 2006). Our robustness models then further isolate the effects of drought_t by controlling for additional cell-level variables such as ln precipitation_t, temperature_t, and drought_{t-1}.

35. That is, a count of the number of politically relevant ethnic groups in a particular cell (Tollefsen et al. 2012).

In order to better ensure that it is indeed drought$_t$—and not the country-level political-economic conditions that could potentially exacerbate the effects of droughts—that are affecting atrocities$_t$, a larger specification presented below also includes a number of additional country-year level controls. We again lag each control by one calender year where appropriate. These country-year control variables first account for a country's political regime via an ordinal polity$_{t-1}$ indicator (Marshall, Jaggers, and Gurr 2013), as political regime type is related to both atrocities against civilians (e.g., Ulfelder 2012) and agricultural development (Bates and Block 2013). Next, we add a country's overall ln GDP pc$_{t-1}$ (World Bank 2012), given that aggregate economic development has been shown to be associated with atrocities (Ulfelder 2012). We then cluster our standard errors on cell ID in all models below and add cubic polynomials for time to account for temporal dependence in our largest specifications.

Finally, we add several control variables to the inflation stage of our ZINB models. Recall that this stage accounts for the factors that systematically predispose some cells to be structurally (non) atrocity prone. As population presence is a necessary condition for a cell to have at least some opportunity for rebel-perpetrated atrocities, we include our three primary population measures, ln travel time$_t$ to the nearest major city, urban$_t$ land area, and ln population$_{t-1}$ within our inflation stage. We expect these to be positively (ln travel time$_t$) and negatively (urban$_t$ and population$_t$) associated with inflation. Our justification for including population-oriented variables in our inflation stages is consistent with civil conflict research (Fjelde and Hultman 2014; Hegre et al. 2009). We argued more generally above that stable sociopolitical environments, harmonies of interests, and an absence of violence each limit the opportunities for atrocities to arise within some cells and regions. Hence, we also include our cell-level civil conflict$_{t-1}$ measure, and later our country-level indicators of polity$_{t-1}$ and ln GDP pc$_{t-1}$, in our inflation stages. While we demonstrate above that civil conflict$_{t-1}$ does not predict rebel-perpetrated atrocities in a deterministic sense, we do believe it to affect atrocity opportunity in a probabilistic sense. This is consistent with conflict studies employing ZINB models, which have demonstrated that past civil conflict is a robust predictor of zero inflation in these contexts (e.g., Bagozzi 2015; Fjelde and Hultman 2014). Finally, while our theory contends that drought$_{t-1}$ will affect the incidence of atrocities$_t$, we additionally control for drought$_{t-1}$ in the inflation stage of our large ZINB specification so as to ensure that our primary findings are also robust to the inclusion of drought$_{t-1}$ in this stage.[36]

36. We thank an anonymous reviewer for this suggestion.

Results

Table 1 first reports a baseline NB model of rebel-perpetrated atrocities, which includes drought$_t$ and several key cell-level controls. This model is followed by a comparable ZINB model that includes our aforementioned cell-level inflation stage covariates, a medium ZINB specification that includes our full set of cell and country-level control variables, and then a full ZINB specification that adds our spatial and temporal controls. All results strongly support the hypothesized effect of drought$_t$ on atrocities. The baseline NB model suggests that—controlling for a cell's recent levels of civil conflict, population, and geographic location—increases in drought$_t$ have a statistically significant positive effect on the frequency of rebel-perpetrated atrocities. Our baseline and medium ZINB specifications similarly indicate that once one has controlled for these factors, in addition to conditioning on an observation being a potential atrocity site in year *t*, drought$_t$ continues to have a positive and statistically significant effect on atrocities. The full ZINB model demonstrates that this statistically significant effect of drought$_t$ remains even after further controlling for a cell's potential spatial and temporal dependencies. Table 1 therefore supports our hypothesis and suggest that, (un)conditional on a cell being able to experience rebel-perpetrated atrocities in year *t*, the presence of droughts increases the rate at which civilians in that geographic area experience atrocities at the hands of rebels.

Next, we examine the inflation stages of models 2–4 to verify that our decision to use zero-inflated models was defensible. As expected, the inflation stage estimate for civil conflict$_{t-1}$ is consistently negative and significant, suggesting that civil conflicts make a cell less likely to be inflated and thus more likely to be able to experience rebel atrocities. Ln population is negative and significant in models 2–4, implying that more populated cells are more able to experience rebel atrocities in year *t*. Urban$_t$ is negative and significant in model 2 but insignificant in models 3–4. The former result implies that, like population, more urbanized (i.e., populated) cells are more likely to be able to experience atrocities in the present year. Controlling for these population dynamics, the negative and significant coefficient estimate on ln travel time$_t$ in models 3–4 implies that more rural cells are more apt to experience such conflicts. While ln GDP pc$_{t-1}$ is not consistently significant, Polity$_{t-1}$ is negative and significant in the ZINB stage of models 3–4, indicating that more democratic countries are more able to experience rebel-perpetrated atrocities. Finally, drought$_t$ is insignificant in our inflation stages. In sum, our inflation stage generally performs as expected, which suggests that our decision to account for inflation was correct.

To assess the substantive impact of drought$_t$, we next turn to table 2, which presents the percentage differences in

Table 1. Count Model Estimates of Rebel-Perpetrated Atrocities, 1995–2008

	Model 1: Baseline NB	SE	Model 2: Baseline ZINB	SE	Model 3: Medium ZINB	SE	Model 4: Full ZINB	SE
Count stage:								
Drought$_t$	.313*	(.127)	.397*	(.144)	.508*	(.218)	.336*	(.130)
Civil conflict$_{t-1}$	2.119*	(.095)	.825*	(.250)	.919*	(.417)	.238*	(.076)
Ln travel time$_t$	.016	(.152)	−.195	(.261)	.213	(.353)	.035	(.099)
Ln cell area$_t$	.050	(.134)	.0002	(.135)	−.170	(.171)	−.105	(.111)
Ln population$_{t-1}$	.605*	(.064)	.319*	(.112)	.588*	(.238)	.077	(.064)
Ln GCP$_{t-1}$	. . .	. . .	. . .	. . .	−.174	(.136)	−.019	(.083)
Polity$_{t-1}$	. . .	. . .	. . .	. . .	−.081	(.029)	−.001	(.007)
Ln border distance$_t$	. . .	. . .	. . .	. . .	.378*	(.074)	.025	(.025)
Urban$_t$	. . .	. . .	. . .	. . .	.033	(.034)	.019	(.020)
Cropland	. . .	. . .	. . .	. . .	−.009*	(.003)	−.001	(.002)
Ethnic diversity$_{t-1}$	. . .	. . .	. . .	. . .	−.039	(.075)	−.044	(.034)
Ln GDP pc$_{t-1}$	. . .	. . .	. . .	. . .	.546*	(.167)	−.019	(.072)
Splag atrocities DV$_{t-1}$	. . .	. . .	. . .	. . .	. . .	. . .	.645*	(.149)
t	. . .	. . .	. . .	. . .	. . .	. . .	−40.149*	(.134)
t^2	. . .	. . .	. . .	. . .	. . .	. . .	20.061*	(.078)
t^3	. . .	. . .	. . .	. . .	. . .	. . .	−3.459*	(.014)
Constant	−.478	(.779)	−6.361*	(1.955)	12.354*	(5.627)	.016	(1.412)
Inflation stage:								
Ln population$_{t-1}$	. . .	. . .	−.354*	(.134)	−.412*	(.210)	−.458*	(.063)
Ln travel time$_t$	. . .	. . .	−.333	(.227)	−.072*	(.231)	−.684*	(.132)
Civil conflict$_{t-1}$	. . .	. . .	−1.827*	(.198)	−2.727*	(.282)	−5.408*	(.097)
Urban$_t$	. . .	. . .	−.124*	(.041)	−.123	(.068)	−.038	(.022)
Ln GDP pc$_{t-1}$	. . .	. . .	. . .	. . .	1.146*	(.467)	−.186	(.103)
Polity$_{t-1}$	. . .	. . .	. . .	. . .	−.162*	(.062)	−.042*	(.013)
Drought$_t$	. . .	. . .	. . .	. . .	.307	(.302)	−.017	(.228)
Constant	. . .	. . .	8.092*	(1.910)	−2.325	(7.664)	−10.814	(1.785)
Observations	366,124		366,124		333,243		333,243	
Log-psuedolikelihood	−9,593.36		−9,499.24		−7,197.42		−1,665.74	

Note. NB = negative binomial; ZINB = zero-inflated negative binomial. Values in parentheses are robust standard errors clustered by cell ID.
* $p < .05$.

expected values of rebel-perpetrated atrocities$_t$, given an increase in drought$_t$ from 0 (no drought) to 1 (severe drought), and compares this first difference to those derived from two additional highly significant predictors of atrocities$_t$: (i) a 0 to 1 change in civil conflict$_{t-1}$ and (ii) one standard deviation (SD) increase in the spatial lag of atrocities$_{t-1}$. For each first difference, we hold all other variables at their means or modes.[37] The changes that we observe in a cell's estimated level of rebel-perpetrated atrocities in response to an extreme drought are substantial. Experiencing a severe drought is expected to lead to a 41.12% increase in the expected number of yearly rebel-perpetrated atrocities. This percentage change is (i) moderately larger to what we would expect to see given a 0 to 1 change 1 SD increase in civil conflict$_{t-1}$ (+ 27.13%), and substantially larger than the effect of a 1 SD change in the spatial lag of atrocities$_{t-1}$ (+ 1.98%). Hence, the first-differences presented in table 2 indicate that the substantive effects of drought$_t$ are indeed sizable.

Robustness tests

To evaluate the sensitivity of our findings, we examine a number of alternative specifications in the appendix. For these robustness tests, we estimate the "full" ZINB specification presented in table 1 and then assess the statistical significance of each drought coefficient estimate therein. To begin, we first separately verify that our results are robust to the inclusion of (i) year fixed effects and (ii) a spatially lagged dependent variable in inflation stage of our full ZINB specification. We then assess whether our findings for drought$_t$ are arising due to omitted variable bias, with particular re-

37. These quantities were calculated from the outcome stage of our model 4 estimates and thus report the effects of each variable on an (already) atrocities-prone observation.

Table 2. Percentage Change in Expected Atrocities Count in Year t

Drought$_t$	Civil Conflict$_{t-1}$	Splag Atrocities DV$_{t-1}$
+ 41.12%	+ 27.23%	+ 1.98%
(+ 8.64% ↔ + 80.77%)	(+ 9.42 ↔ + 47.03)	(+ 1.09% ↔ + 2.87%)

Note. Drought$_t$ and civil conflict$_{t-1}$ were each changed from 0 → 1. The spatial lag of atrocities DV$_{t-1}$ was increased 1 SD above its mean. Values in parentheses are 95% confidence intervals.

gard to a selection of additional controls for a country's degree of ethnic fractionalization, polity$^2_{t-1}$, a cell's annual temperature, each cell's (logged) level of annual precipitation, and cell-level government-perpetrated atrocities$_{t-1}$. Our primary conclusions remain after adding these additional controls.[38] We next evaluate an alternative operationalization of drought$_t$ by including the complete SPI (discussed above) in place of drought$_t$. Our findings remain comparable when using this more graded measure of (extreme) local dryness.

Likelihood ratio tests favor the ZINB over the ZIP for all models in table 1. Nevertheless, we also verify that our findings are robust to the latter. Our developing country sample is global, whereas the study of atrocities, as well as studies of the effects of climatic factors on political violence, have predominately focused on the African continent. Addressing this distinction, we find that our results are robust to an exclusive focus on the African continent. We likewise obtain positive and significant findings for drought$_t$ when using a dependent atrocities variable derived from the Georeferenced Events Dataset (GED; Sundberg and Melander 2013) as opposed to our PITF-based measure. We next examine a model that uses a sample of all developing country "rural" grid cells based upon whether urban land area is scarce to nonexistent, rather than based upon whether some positive amount of cropland is present. This robustness model indicates that our primary conclusions hold under this alternative threshold for a (rural) cell's inclusion in our sample. Finally, we also evaluate the robustness of all models reported in table 1 while including all developing country grid cells—and find that our conclusions are robust to these adjustments as well.

CONCLUSION

This paper contends that droughts can increase the incidence of rebel-perpetrated atrocities against civilians in agricultural areas of developing countries. When severe droughts occur, our formal model posits that agriculture resources diminish, leading civilians to allocate more agricultural supplies for consumption and to invest more in defending their diminishing supplies. In response, rebels will attempt to preempt civilians' defensive efforts by seeking to forcibly evict civilians from their homes and croplands. This strategy drives rebels to commit atrocities, as atrocities induce civilians to flee from their land or otherwise give up food resources. After deriving these propositions formally, we empirically establish that droughts are a consistent positive indicator of rebel-perpetrated atrocities against civilians.

Our findings have a number of important implications for the study of violence against civilians. In recent years, the study of rebel-perpetrated atrocities has greatly benefited from numerous exceptional theories of the strategic dynamics underlying rebels' decisions to employ violence against civilians within conflict settings (e.g., Azam and Hoeffler 2002; Fjelde and Hultman 2014; Wood 2010). Yet, as noted above, a high proportion of contemporary rebel-perpetrated atrocities not only occur predominantly within agricultural regions but also transpire in locations that are not currently experiencing active fighting between rebels and government forces. To explain this variation, we develop a game-theoretic model that does not necessitate the existence of active civil conflict as a prerequisite for violence against civilians. Drawing on extant research concerned with the effects of climatic factors on conflict (e.g., Buhaug 2010; Burke et al. 2009; Hendrix and Salehyan 2012), we then find drought to be an important causal mechanism in promoting atrocities in rural developing areas. These contributions represent an important step forward in advancing our understandings of political violence and the factors governing its variation.

Given the likelihood of more severe global droughts in future years due to climate change (Vidal 2013), the identified linkages between droughts and atrocities also have important policy relevance. Indeed, this study has not only identified a salient predictor of atrocities but has also illuminated a possible mechanism by which a subset of atrocities could be ameliorated; through better drought preparedness and agricultural assistance within atrocity-prone regions of the world. Our findings also suggest that improved food security may more generally help regions avoid atrocities both

38. Though drought$_t$ is now only significant at the $p < .10$ level.

during and between periods of active fighting. A key insight of our theory is that food insecurity, and drought-based shocks to food security, can undermine food access, which in turn increases rebel forces' pursuit of violence against civilians and the levels of civilian resistance in response to such tactics. These trends are apt to grow in the future, as the effects of climate change increasingly undermine food security in the developing world. As such, the study of climate change's varied effects on atrocities against civilians represents an especially compelling area for future research.

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