Strategic Mass Killings*

Joan Esteban†
Institut d'Analisis Economica, CSIC and Barcelona GSE

Massimo Morelli‡
Columbia University and NBER

Dominic Rohner§
University of Lausanne

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Abstract

We provide a model of conflict and mass killing decisions, to identify the key variables and situations that make mass killings more likely to occur. We predict that mass killings are most likely in countries with large amounts of natural resource rents, polarization, institutional constraints regarding rent sharing, and low productivity of labor. The role of resources like oil, gas and diamonds and other key determinants of mass killings is

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†Email: joan.esteban@iae.csic.es.

‡Email: mm3331@columbia.edu.

§Email: dominic.rohner@unil.ch.

confirmed by our empirical results based on country level as well as ethnic group level analysis.

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1 Introduction

Since World War II some 50 episodes of mass killings have led to between 12 and 25 million civilian casualties (Political Instability Task Force 2010)[1] and by 2008 have induced the displacement of 42 million people (UNHCR, 2009). Surprisingly, while there is an increasing number of formal models of civil and interstate wars (surveyed by Blattman and Miguel 2010, and Jackson and Morelli 2011), the issues of mass killings and forced displacements of civilians have so far been largely neglected as far as formal rational explanations are concerned. In this paper, we study whether decisions to engage in mass killings can be explained as the result of strategic, rational calculation.

The mass killing in Sudan's Darfur region that started in 2003 illustrates the key features we wish to emphasize as most relevant for the explanation of mass killing incentives. The first feature is a set of distinct, identifiable groups. The primary perpetrators of the killings and expulsions in Darfur were government-backed "Arab" militias. The main civilian victims were black "Africans" (Straus, 2005). The second feature is a large amount of resource wealth relative to non-resource productivity. The early 21st century was characterized by natural resource shocks (Sudan becomes an increasingly important oil producer). At the same time productivity and state capacity of Sudan remained very low. The estimates of the death toll vary between 70,000 and 400,000 fatalities, with an estimated 1.8 million people displaced (Straus, 2005, 2006; Waal, 2007). This corresponds to a significant fraction of the total population in this region, which was about 6.5 million before the outbreak of the crisis. The killings were clearly strategic, "directed by the state, targeted at a particular ethnic population, and intended to destroy that ethnic population in substantial part" (Straus, 2006: 43). Reducing the population size of the opponent group by extermination allows the perpetrator to obtain a larger share in the future distribution of surplus. This incentive is particularly relevant within

[1] We adopt the definition in Charny (1999: 7) and Easterly, Gatti and Kurlat (2006: 132): "Mass killings are the killings of substantial numbers of human beings, when not in the course of military action against the military forces of an avowed enemy, under the conditions of the essential defenselessness and helplessness of the victims". The estimates of how many civilian fatalities have fallen in this category vary a lot because of the difficulties in identifying degrees of intentionality and targeting, but they are substantial by any standard. In contrast with the estimate by the "Political Instability Task Force", Bae and Ott (2008) use even larger numbers: The conflict-related deaths in the 20th century were as large as 109.7 millions, corresponding to 4.35 percent of the world population. Of these, 60 percent were civilian non-combatants.

countries with well defined ethnic groups and where the government is basically controlled by one of them.

In line with the above anecdotal intuition about the key potential drivers of mass killing incentives, we introduce a formal model with the following characteristics: the population is divided in two identifiable groups and one of them initially controls the government; in every period of the game the two groups decide whether to go to war with each other or not, and peace prevails if and only if both groups choose to maintain peace; whoever is in power at the end of a period decides unilaterally the distribution of the surplus of that period's production as well as whether or not to commit mass killings. We analyze first an *unlimited power* benchmark, in which the only limits to exploitation and elimination of opponents are endogenous. We then generalize the analysis to include the possibility of *exogenous bounds* to the exercise of power, such as a minimum share of resources that must be given to any group, or limits on the ability to kill.

We characterize the best (total-surplus-maximizing) Subgame Perfect Equilibrium of the infinite horizon game between the two groups. We find that the likelihood of mass killings is increasing in natural resource abundance and decreasing in labor productivity and destruction costs of war. Moreover, we find that group polarization increases the likelihood of mass killings, whereas an increase in population size (keeping polarization constant) reduces the probability of such events. Finally, we find that a tightening of institutional constraints to distributive power increases the probability of mass killings whenever the constraint binds; while a tightening of the constraints on the power to kill has ambiguous effects, and can in some situations –maybe paradoxically– fuel killing incentives.

The main trade-off for a group holding power is as follows. The elimination of minority members in the present reduces the future constraints on surplus sharing, but on the other hand reduces future production in labor intensive sectors, hence the trade-off is intuitively affected by the relative preponderance of natural resources.

Starting from a situation in which the institutional constraints to unfairness in surplus sharing are limited (for example starting from an effective dictatorship), an increase in the institutional lower bound to unfairness (for example caused by greater checks and balances typical of a democratization process) can have ambiguous effects on violence: on the one hand, an exogenous increase in institutional constraints to unfairness obviously reduces the motivations to rebel; on the other hand, such a change in the institutional constraints makes it harder to expropriate a group when it is out of power, and therefore more attractive to eliminate the group entirely through mass killings.

Inspired by our theoretical model and by its predictions, we present a novel empirical analysis of mass killings, studying the effects of natural resource rents and all the other key variables of the theory, at the country and ethnic group levels. As suggested by the theory, our empirical analysis confirms that natural resource rents are a robust and very significant predictor of mass killings, while a high labor productivity is found to discourage massacres. Mass killings are also significantly more likely after recent democratization and in small, ethnically polarized countries. Further, we find that –when controlling for the country characteristics– ethnic groups are significantly more likely to be massacred if they are relatively small and resource-rich, which is in line with our theory. In contrast, these findings are not easy to reconcile with alternative mechanisms suggesting for example that oil may fuel mass killings by making oil-rich groups more powerful. If this alternative explanation were driving the correlation between oil and mass killings, we should expect oil-poor groups to be the main targets, which contradicts our empirical results.

This paper contributes to several strands of the existing literature. There is a theoretical literature on slavery and forced labor (see e.g. Domar, 1970; Lagerlöf, 2009; Acemoglu and Wolitzky, 2011), although the dynamic incentives are very different from the ones for mass killings. The literature on battle-related, two-sided violence in civil wars is also complementary to our work (e.g. Humphreys and Weinstein 2006, and Kalyvas 2007). Powell's (1996) "declining State" explanation for war is relevant as well, although in our model the minority group's expected future weakening depends directly on actions that the group in power will take if power remains in their hands.

For previous empirical work on mass killings, see Rummel (1994, 1995); Krain (1997); Scully (1997); Harff (2003); Valentino, Huth and Balch-Lindsay (2004); Besançon (2005); Easterly, Gatti and Kurlat (2006); Eck and Hultman (2007); Heger and Salehyan (2007); Colaresi and Carey (2008); Bae and Ott (2008); Montalvo and Reynal-Querol (2008); Querido (2009). With the exception of Querido (2009), these articles focus mostly on the impact of poverty, ethnic diversity and political regimes, whereas we will put emphasis on natural resource variables and on the role of the process of democratization. Moreover, we are the first to study mass killings both at the country level and using an ethnic-group level panel.

The paper is organized as follows: In section 2 we discuss the main elements that need to be considered in the analysis of mass killings; in section 3 we introduce our model; in sections 4 and 5 we present all our theoretical findings and predictions. Section 6 contains the empirical analysis, and section 7 concludes. As usual, technical and supplemental materials are relegated to the appendix.

2 Important Patterns of Mass Killings

Before diving into the analysis, it is useful to highlight the main patterns of mass killings.

The first fact to highlight is that almost all mass killing episodes in history were perpetrated by governments or dominant groups (see Harff, 2003; Valentino, Huth and Balch-Lindsay, 2004; Eck and Hultman, 2007). In order to be able to carry out mass killings, a group needs to handle power and control the military.[2] A quote from Krain (2000: 43) illustrates this well: "Military

[2] Rebel groups are responsible for a very small part of mass killings of civilians, and they are more likely to engage in killings if they are militarily strong relative to the government

victories by definition enable the winner to set the terms of the post-internal war period. This may include the decision to punish the losing side by eradicating them, thereby eliminating the problem of having to live side by side with the enemy in the post-internal war state. This was the solution chosen by the Congolese rebels who took control of what would become Zaire in the mid-1960s". Or in the words of Chirot and McCauley (2006: 2), "conflict can become genocidal when powerful groups think that the most efficient means to get what they want is to eliminate those in the way."

Rummel (1994, 1995) points out that "power kills, absolute power kills absolutely" (1994: 1), and gives a strong quantitative idea of the preponderance of government decided killings, when he states that "political regimes — governments— have probably murdered nearly 170,000,000 of their own citizens and foreigners in this century — about four times the number killed in all international and domestic wars and revolutions." (Rummel, 1995: 3).

Another fact worth noting is that most mass killing events take place towards the end or after wars (Krain, 2000; Valentino, Huth and Balch-Lindsay, 2004). The usual sequence of events is indeed that there is first a civil war and mass killings only take place after victory. To put it in Krain's (2000: 46) words, "internal wars are lethal twice over–in the actual bloody conflict, and in the enhanced potential for state-sponsored mass murder subsequently".

A third stylized fact to keep in mind is that not all forms of war are equally likely to be accompanied by mass killings. A substantial fraction of civil wars entail deliberate mass killings of civil non-combatants on a large scale perpetrated by the dominant group, while there is almost no record of mass killings of this sort in post-WWII interstate wars. Between 1960 and 2000 roughly a third of all civil wars (50 out of 152) featured mass killings, while in none of the interstate wars (23) were there mass killings.[3] In interstate disputes there is no supranational government budget to fight for in terms of entitlements or alike, and hence interstate wars typically take the form of territorial wars (Caselli, Morelli and Rohner 2013).

One distinctive feature of mass killings that clearly separates this deadly option from other forms of weakening the opposition group (e.g. imprisonments, internments, expropriations and disenfranchisements) is that mass killings are designed to reduce the size of the opponent groups, either directly or by causing refugee outflows and displacements (multiplier effect, see Krain 2000: 41).

The model we now turn to is greatly motivated by all these facts.

(Hultman, 2009) and after having won a military battle (Schneider, Bussmann, and Ruhe, 2012). Usually killings by rebels take the form and objectives of terrorism, which is beyond the scope of this paper (for this separate literature, see e.g. Azam and Hoeffler, 2002; and Bueno de Mesquita, 2010).

[3] To compute this, we took data on mass killings in wars from Valentino, Huth and Balch-Lindsay (2004), civil wars data from Collier, Hoeffler and Rohner (2009), and data on interstate wars from Gleditsch and Ward (2007). According to Valentino, Huth and Balch-Lindsay (2004) the only mass killings during interstate war in recent decades took place during the Korean War, 1950-53 (which shared many features with civil wars).

3 Model

There are two groups, i and j, with initial population sizes N_i, N_j. Without loss of generality, let j be the group in power in the initial period in the analysis. The social surplus S to be shared in each period comes from two sources: (i) a constant per-period amount R from the exploitation of a natural resource; and (ii) output produced by labor, for which we assume a rigid labor supply, so that the output of production at time t is $\beta N^t = \beta(N_i^t + N_j^t)$. We can think of $\beta > 0$ as individual productivity determined by education as well as by technology. Hence, the surplus to be shared in the first period is

$$S = \beta(N_i + N_j) + R.$$

In the following periods in the infinite horizon game the only potential alteration of such a per period surplus can come via changes in the population size.

We assume that if there is conflict in a period, the winner seizes the entire surplus of that period, minus a loss d caused by the conflict. We also assume that the probability of victory in war at time t for group h, $h = i, j$, is equal to the relative population size in that period, $\frac{N_h^t}{N^t}$.

The common discount factor is denoted as usual by $\delta \in [0, 1)$. The last piece of notation is the fairness level λ_h^t chosen by h when in power at time t: if h is in power and offers a share x_h^t of the surplus to group $k \neq h$, such a share x_h^t is decomposed as a fairness parameter λ_h^t times the relative group size of group k at the time of surplus sharing, $x_h^t = \lambda_h^t \frac{N_k^t}{N^t}$, with $\lambda_h^t \in [0, \frac{N^t}{N_k^t}]$.

Let group h be in power at the beginning of time t. The time line in period t is as follows:

1. *Production*: Production takes place, the surplus is collected and the group in power announces a distribution of this surplus between the two groups.

2. *Peace or Conflict*: The two groups decide simultaneously whether to have conflict or peace, where peace prevails only if both choose peace. In case of conflict an amount d of the surplus is destroyed. Group h remains in power in case of peace and in case it wins the war, whereas group $k \neq h$ obtains power only by winning the civil war.

3. *Exercise of power:* This has two dimensions. First, the group in power keeps all the surplus in case of victory or carries out the announced distribution in case of peace. Second, the ruler may decide to eliminate members of the other group, without surpassing a cumulative upper bound $\overline{M}$.

4. *Consumption*: Consumption takes place.

Even though the game is not technically a repeated game (given that the population size and the identity of the group in power are state variables that can make the stage game in two consecutive periods different), the multiplicity of subgame perfect equilibria of this game follows a similar logic to that of standard folk theorems. Hence, as it is common practice in repeated games, we focus on the characterization of the *best* subgame perfect equilibrium (SPE), i.e., on the SPE that maximizes social surplus. Henceforth in the paper we will refer to this equilibrium selection as best SPE or as "*the equilibrium*", when it does not create confusion.

Focusing on the best equilibrium is particularly common in Industrial Organization (e.g. Levin, 2003). For recent articles in Political Economics focusing on the best equilibrium see for example Yared (2010), van Weelden (2013) and Wolitzky (2013). Beside being common practice, this equilibrium selection has an important conceptual motivation for our objectives: showing that war and mass killings could occur in some "bad" equilibrium due to coordination failures when other equilibria without violence also exist, would be, in our view, much less interesting and forceful. It is when the best SPE displays war and mass killings that we obtain the sense that such events are inescapable for certain situations, whereas when players could coordinate on a better equilibrium the sense of inescapable faith would be lost.

In order to characterize the "best" SPE, we will first characterize the "worst" SPE, i.e. the one with the smallest social surplus. Then, in the construction of the best SPE, we follow Abreu (1986, 1988) (see also Fudenberg and Tirole, 1991: 160ff) using the worst equilibrium strategy as a punishment threat against any deviation from the best equilibrium strategy.[4] Hence, to achieve the best SPE, both players follow a "grim trigger profile", which is defined as the credible threat to play the worst SPE following a deviation of the opponent from the best SPE. This phase of worst SPE being played during the entire future after a deviation will be referred to as "punishment phase".

The exercise of power stage of each period is where institutions, regimes, and perhaps third parties, can enter the picture: in the *unlimited power* benchmark, the group in power has full discretion to choose the division of the surplus of that period and the number of killings to perpetrate. However, power is usually limited or constrained, by institutions, social norms, or international pressure, and we will capture these limits to the exercise of power by means of two parameters: $\underline{\lambda}$ and $\overline{M}$.

The first of these two constraints can be interpreted as a constraint to the exploitation of the powerless group: saying that in peace the share of the surplus going to group k cannot be lower than $\underline{\lambda}\frac{N_k^t}{N^t}$ implies that the democratic institutions, checks and balances, or general tolerance of unequal treatment in society do not permit a degree of exploitation represented by any $\lambda < \underline{\lambda}$, and hence implies that if the group in power violates that constraint the standing institutions are violated.

For the upper bound on total allowable mass killings $\overline{M}$ to be binding, it has to be lower than the minimum between N_i and N_j, whereas otherwise the full extermination of a minority group is possible.

[4] Our analysis does not exclude that the same equilibrium outcome could be supported also with less destructive threats.

Note that for both types of bounds not only domestic factors, such as social norms, play a role, but these bounds are also related to the level of pressure from the international community threatening with a military intervention if basic humanitarian rules on fairness or respect for human life are violated.

We organize the analysis as follows: first, in the coming section, we study the benchmark *unlimited power* case, where there are no constraints on either exploitation or mass killings. The degree of exploitation of the powerless group finds its binding constraint in the need to make sure that such a group does not rebel, rather than in exogenous institutions or social norms. Then, in section 5, we will characterize the equilibrium even for the more complex case in which $\underline{\lambda}$ and $\overline{M}$ can be binding, emphasizing the differences in terms of predictions with respect to the unlimited power benchmark.

4 Equilibrium Analysis with Unlimited Power

In this section we characterize the equilibrium in the unlimited power case. We shall start with a series of claims that will be used for the construction of the Lemma characterizing the worst SPE.

Claim 1 *Because of the simultaneous move war declaration stage, there always exist equilibria with war at the very start of the game. The punishment phase of a grim trigger profile always starts with a war.*

However:

Claim 2 *War forever cannot be sustained as SPE.*

Proof. The winner of the first war can choose the level of mass killings M and λ without constraints. Let us show that choosing $M = 0$ in anticipation of more periods of war and no mass killings cannot be rational.

Suppose first that group i would never want to do mass killings. Consider a subgame after a war that ended with a victory of j, at a history with no prior mass killing. Group j's trade-off at that node is as follows: When exterminating the opponent it obtains:

$$S - d + \frac{\delta}{1-\delta}(S - \beta N_i);$$

when renouncing to do mass killings, continuing the war path, it obtains[5]

$$\left[1 + \frac{\delta}{1-\delta}\frac{N_j}{N}\right](S - d).$$

[5] To see this, consider the value for j to be in power when entering a new period, denoting it by V_j^j:

$$V_j^j = \frac{N_j}{N}\left[(S-d) + \delta V_j^j\right] + \frac{N_i}{N}\delta V_j^i,$$

where V_j^i is the value for j after giving up power to i. Under permanent conflict, the value of being in opposition is identical to that of being in power because power doesn't give any strategic advantage, so that $V_j^j = V_j^i = V_j$. Hence, $V_j = \frac{N_j}{N}\frac{S-d}{1-\delta}$. Consequently, the payoff from winning and not exterminating the opponent is $(S-d) + \delta V_j$.

It is easy to see that mass killings are always preferred to continued conflict. A fortiori, if group i allowed itself to do mass killings, group j would have an even larger relative gain from mass killings at the node of exercise of power after victory in a civil war. The same logic applies if i is in power after the first war. ■

Claim 3 *There exists a SPE strategy profile Σ^o in which (1) both groups always choose war in any period where they both exist, and (2) there is full extermination of the opponent by whoever is in power at the first occasion.*

Proof. Deviating by not selecting war is not a worthwhile deviation, as war will occur as long as at least one of the players selects it. The only one-period deviation to be evaluated is the decision by a winning group h to choose $M < N_k$, $k \neq h$. After such a one-period deviation from full extermination, in the following period a new war takes place, followed by extermination by the winner. When doing full extermination, group h obtains:

$$S - d + \frac{\delta}{1-\delta}(S - \beta N_k).$$

In contrast, when doing $M < N_k$ group h obtains after reformulation the expected payoff

$$S - d + \frac{N_h}{N-M}\delta\left[S - \beta M - d + \frac{\delta}{1-\delta}(S - \beta N_k)\right],$$

which is always smaller than the payoff from doing full mass killings right away. Hence, there cannot be a worthwhile deviation, and the strategy profile Σ^o with full extermination by whoever is in power at the first occasion must be an equilibrium. ■

The above claims allow us to state the following lemma:

Lemma 1 *Σ^o is the worst SPE of the game, consisting of strategies by the two players with immediate war followed by full mass killings by the winner.*

We are now ready to characterize the best SPE, obtained by reverting to Σ^o after any deviation.

Consider a candidate stationary SPE path in which j remains in power forever, there is never war nor mass killings, and the fairness level is λ_j every period, whereas after any deviation from this path the two players enter the punishment phase constituted by the worst SPE continuation characterized above.

Conditional on having had peace before, the value for group i from continuing on path is

$$\frac{1}{1-\delta}\lambda_j \frac{N_i}{N} S,$$

while when rebelling (hence switching to the worst path) it obtains

$$\frac{N_i}{N}\left(S-d+\frac{\delta}{1-\delta}(S-\beta N_j)\right).$$

Thus, i prefers the stationary peaceful path as long as

$$\frac{1}{1-\delta}\lambda_j S > S-d+\frac{\delta}{1-\delta}(S-\beta N_j),$$

that is

$$\lambda_j \geq \lambda_j^o \equiv \frac{S-d(1-\delta)-\delta\beta N_j}{S}. \tag{1}$$

Note that λ_j^o is increasing in R, meaning that the more natural resource rents there are, the more difficult it is to keep the minority group peaceful.[6] Further, λ_j^o is decreasing in d, which is due to the fact that high destruction costs of war deter rebellion.

Now that we have computed the λ_j^o that, if chosen every period, eliminates the incentives to deviate for group i, we need to check the incentives to deviate by group j.

Group j's payoff of buying peace in all periods is

$$\begin{aligned}\left(1-\frac{N_i}{N}\lambda_j^o\right)\frac{S}{1-\delta} &= \left(1-\frac{N_i}{N}\frac{S-d(1-\delta)-\delta\beta N_j}{S}\right)\frac{S}{1-\delta} \\ &= \frac{\frac{N_j}{N}S+\frac{N_i}{N}(d(1-\delta)+\delta\beta N_j)}{1-\delta}.\end{aligned}$$

Two types of deviations are possible: *mass killings* or *exploitation*, where by the latter we mean the decision by group j to give $\lambda_j = 0$ in the deviation period. With the mass killings deviation, group j obtains

$$S+\frac{\delta}{1-\delta}(S-\beta N_i). \tag{2}$$

With the exploitation deviation, on the other hand, group j obtains

$$S+\delta\frac{N_j}{N}\left[S-d+\frac{\delta}{1-\delta}(S-\beta N_i)\right]. \tag{3}$$

It is immediate that the payoff from mass killings is always larger than the payoff of exploitation alone. Hence, the most profitable deviation to consider is mass killings.

Peace is preferred by j to mass killings iff

$$\frac{\frac{N_j}{N}S+\frac{N_i}{N}(d(1-\delta)+\delta\beta N_j)}{1-\delta} > S+\frac{\delta}{1-\delta}(S-\beta N_i).$$

[6] Note also that if $d > (<)\beta N_j$, then λ_j^o is increasing (resp. decreasing) in δ. Intuitively, when the (immediate) loss of war weights heavier than the (future) production loss from having a decimated population, then an impatient opposition is less inclined to rebel.

After some manipulations, the condition can be written as follows:

$$R < R_j^o \equiv \delta\beta N_j - (1-\delta)(\beta N - d). \tag{4}$$

This is the "No-MK IC" condition. Similarly, the No-MK IC condition when i is in power is $R < R_i^o \equiv \delta\beta N_i - (1-\delta)(\beta N - d)$.

All the above analysis leads to the following lemma:

Lemma 2 *(I) If $R < R_j^o$, the best SPE is a peaceful steady state with fairness level λ_j^o, which is increasing in R.*

(II) If $R > R_j^o$, the best SPE involves war, and extermination at the first occasion, perpetrated by whoever is in power at the end of the war.

We remark that in the unlimited power case there are no parameter values under which the best SPE involves exploitation:

Remark 4 *There are no parameter values under which the best SPE can display exploitation ($\lambda_j = 0$) without mass killings.*

To see this, note that the immediate effects of exploitation and mass killings in terms of distributive consequences are the same, as far as the payoffs for the governing group in that period are concerned. Further, we know that in both cases j would trigger a punishment phase with war and mass killings, where j would risk to be the one killed. This is always dominated by killing right away, as follows from equations (2)-(3).

Proposition 1 below displays the comparative statics from the equilibrium characterization obtained above, i.e. the effect of changes in the value of the different parameters on the resource threshold for mass killing incentive.

Proposition 1: *There is an increase in the value of the threshold level of R above which an equilibrium with mass killings exists when:*

- *d is larger*;
- *the size of the group in opposition N_i/N is smaller, and hence the size of the group in power N_j/N is larger;*[7]
- *β or N are larger, for δ sufficiently high*;
- *δ is larger, unless d is very large.*

5 Equilibrium Analysis with Bounds on Power

We shall now allow the possibility that the limits to the exercise of power $\underline{\lambda}$ and $\overline{M}$ may be binding.

[7] On average, one should expect larger groups to be more frequently in office than smaller groups. In the frequent case where the group in power is the larger group, a decrease in the size of the group out of power corresponds to lower polarization.

5.1 Binding constraint on exploitation only

Let us first analyze what happens when $\underline{\lambda} > \lambda_j^o(R)$, i.e., when the limit to exploitation is binding, while for now let us keep the constraint on mass killings not binding.

Note first that when offered $\underline{\lambda}$, group i is willing to keep peace, given that $\underline{\lambda} > \lambda_j^o$. The incentive constraint that matters is therefore the one concerning the group in power: under what conditions does j offer $\underline{\lambda}$ rather than deviating to full exploitation, abandoning all constitutional constraints, or to mass killings?

The payoff for j from peace is

$$\frac{(1 - \frac{N_i}{N}\underline{\lambda})S}{1-\delta}.$$

The payoff for j from deviating and exterminating group i is

$$S + \frac{\delta}{1-\delta}(S - \beta N_i).$$

Thus, group j will remain peaceful and refrain from mass killings iff

$$\underline{\lambda} < L(R) \equiv \delta \frac{\beta N}{\beta N + R}. \tag{5}$$

Note that $L(R)$ is decreasing in R and equals $\lambda_j^o(R)$ exactly at $R = R_j^o = \delta\beta N_j - (1-\delta)(\beta N - d)$. Recall that exploitation alone ($\lambda = 0$ in the deviation period) is dominated by the extermination deviation, something that is going to be revisited below, in the general case in which bounds exist to both types of exercise of power.

Remark 5 *If $\overline{M}$ is not binding, the comparative statics of Proposition 1 continue to hold even in the presence of a binding $\underline{\lambda}$. The additional result is that the probability of peace is (weakly) decreasing in $\underline{\lambda}$.*

5.2 Worst equilibrium with binding constraints on all forms of power

The next lemma characterizes the worst SPE of the game when on top of bounds on exploitation we also add the bound $\overline{M} < \min\{N_i, N_j\}$ on killings.

Lemma 3 *For any $\overline{M} < \min\{N_i, N_j\}$, and for any $\underline{\lambda}$, the worst SPE is as follows:*

1. *if $R \geq d$, then the worst SPE for the punishment phase involves war every period, with both groups killing $\overline{M}$ opponents at the first occasion of power;*

2. *on the other hand, if $R < d$, the worst SPE involves war forever but without mass killings.*

Proof. Consider a subgame in which one group h has already killed $\overline{M}$ opponents in the past, and hence can no longer access to additional killings. If at the beginning of this subgame h is out of power, then the trade-off for the group k that just conquered power becomes as follows.

If k kills, it obtains

$$\frac{N_k - \overline{M}}{N - 2\overline{M}} \frac{S - 2\beta\overline{M} - d}{1 - \delta},$$

since after the revenge killings the continuation worst SPE involves war forever without further killings allowed.

If k does not kill,[8] it obtains

$$\frac{N_k - \overline{M}}{N - \overline{M}} \frac{S - \beta\overline{M} - d}{1 - \delta}.$$

Thus, performing mass killings is preferred if $R > d$.

Further, if h had the option to still do mass killings in the future, then a fortiori k would have incentives to do mass killings when $R > d$.

In contrast, for $R < d$, when h does indeed not want to kill, then k does not want to kill either, as shown above. This fully characterizes the worst SPE, which always involves war, and hence $\underline{\lambda}$ never matters. ■

Armed with this lemma, we can now characterize the best SPE in the bounded power setting.

5.3 Best equilibrium characterization when both types of power may have binding constraints

In this section, we are going to characterize the best SPE with peace or with conflict by separately examining the cases where $d \geq R$ and $d < R$.

Lemma 4 *Let $d \geq R$. The best SPE involves peace if and only if*

$$d \geq \frac{1 - \delta}{1 + \delta \frac{N_j}{N_i}} S \quad \textit{and} \; \underline{\lambda} \leq \delta \left[1 + \frac{d}{S} \frac{N_j}{N_i} \right].$$

Otherwise, the best SPE involves conflict.

Proof. Consider any equilibrium strategy profile involving peace, assuming it exists, with group j in power offering λ_j every period. From Lemma 3 we know that when group i deviates from peace and engages in rebellion it triggers the punishment phase with conflict in every period but without mass killings. Hence, group i's payoff from rebellion is

$$\frac{N_i}{N} \frac{S - d}{1 - \delta}.$$

[8] Note that if postponing the killings for the future is a preferred strategy, this has to continue to be preferred in any future occasion k is in power. Hence, the relevant strategy alternative to do the killings is to never kill, as we do here.

In contrast, group i's payoff from peace is

$$\lambda_j \frac{N_i}{N} \frac{S}{1-\delta}.$$

Thus, group i (weakly) prefers peace if

$$\lambda_j \geq \max\left\{\underline{\lambda}, 1 - \frac{d}{S}\right\}.$$

Now turn to the trade-off for j. Consider first the case in which $\underline{\lambda} < 1 - \frac{d}{S}$. In this case j's payoff from peace is

$$\left(1 - \left[1 - \frac{d}{S}\right] \frac{N_i}{N}\right) \frac{S}{1-\delta}.$$

Both "exploitation" (i.e. grabbing all the pie, but not doing any mass killings) and mass killings will trigger the punishment phase. Group j's payoff from "exploitation" is

$$S + \frac{\delta}{1-\delta} \frac{N_j}{N} (S - d).$$

The payoff of group j from mass killings is

$$S + \frac{\delta}{1-\delta} \frac{N_j}{N - \overline{M}} (S - \beta\overline{M} - d).$$

Checking which constraint is binding shows that for $R < d$ exploitation is preferred to mass killings, and hence exploitation is the relevant outside option.

Group j prefers peace to exploitation iff:

$$d \geq \frac{1-\delta}{1+\delta\frac{N_j}{N_i}} S.$$

(Note that for $d < S$ this threshold is always bounded between 0 and 1.)

If instead $\underline{\lambda} > 1 - \frac{d}{S}$, the condition under which j prefers peace (having to give $\underline{\lambda}$) over exploitation is

$$\left(1 - \underline{\lambda}\frac{N_i}{N}\right) \frac{S}{1-\delta} > S + \frac{\delta}{1-\delta} \frac{N_j}{N} (S - d).$$

i.e.,

$$\underline{\lambda} \leq \delta \left[1 + \frac{d}{S} \frac{N_j}{N_i}\right].$$

■

The above lemma tells us that there is an important difference between the unlimited power benchmark and the analysis when both types of power can be limited:

Remark 6 *In the presence of effective bounds on power it is no longer the case that exploitation of minority groups is always dominated by mass killings. In fact, when* $d \geq R$ *it is the opposite.*

As long as the non-produced rents R are small relative to the cost of conflict d, there will be no mass killings.[9]

However, for $R > d$ the worst SPE is similar to the one in the unlimited power case, hence the characterization of the best SPE will again involve thresholds below which mass killings will occur, and once again, most importantly, the probability of such a scenario is increasing in R.

Lemma 5 *Let* $\overline{M} < \min\{N_i, N_j\}$ *and* $d < R$. *There exist thresholds* R_h^*, λ_h^* *and* L_h^*, $h = i, j$, *such that*

(i) the best SPE involves peace if and only if $R \leq R_j^*$ *and* $\underline{\lambda} \leq \max\left\{\lambda_j^*, L_j^*\right\}$.

(ii) When $R > R_j^*$ *and/or* $\underline{\lambda} > \max\left\{\lambda_j^*, L_j^*\right\}$, *the best SPE involves war in the first period, and if group* j *wins it commits mass killings* $\overline{M}$. *If group* i *wins it commits mass killings* $\overline{M}$ *iff* $R > R_i^*$ *and/or* $\underline{\lambda} > \max\{\lambda_i^*, L_i^*\}$, *while for* $R \leq R_i^*$ *and* $\underline{\lambda} \leq \max\{\lambda_i^*, L_i^*\}$ *the best SPE involves peace ever after. When mass killings occurred at the end of the first period, there exist thresholds* R_i^{**}, R_j^{**}, L_i^{**} *and* L_j^{**}, *such that (A) if the winner of the first war is* $h = i, j$, *and* $R \leq R_h^{**}$ *(and* $\underline{\lambda} \leq L_h^{**}$, *in case* $\underline{\lambda}$ *is binding), then peace follows ever after; while (B) if* $R > R_h^{**}$ *(and/or* $\underline{\lambda} > L_h^{**}$, *in case* $\underline{\lambda}$ *is binding), then war continues until power shifts, at which point the second mass killing* $\overline{M}$ *takes place, and peace follows after that.*

We relegate the (tedious) proof of this crucial characterization lemma to appendix A (the proof also contains the definitions of all thresholds used in lemma 5). In the zone in between the two thresholds R_i^* and R_j^* the occurrence of mass killings depends on the identity of the winner of the war in the first period.

In Figure 1 we graphically display in the space $(R, \underline{\lambda})$, the different zones derived under the lemmas 4 and 5, for a numerical example with the particular parameter values $d = 50$, $N_i = 50$, $N_j = 50$, $\beta = 1$, $\overline{M} = 5$, and $\delta = 0.6$. Hence, regular produced output (βN) has a value of 100, and the destruction cost of war (d) corresponds in this example to half of the produced output. Other parameter values lead to different sizes of the zones, but *qualitatively* the picture looks the same.[10]

Using the bounds of lemma 4 we can display what happens when $R < d$. In this case, mass killings never occur. Moving to the region where $R > d$, we need to apply the bounds from lemma 5. For values of $R < R^* = 114$ and $\underline{\lambda} < L^*(R)$

[9] This is why in the statement of Lemma 4 we need not refer to whether $\overline{M}$ is larger or smaller than the population of either group.

[10] Naturally, the *quantitative* location of the thresholds depends substantially on the parameter values. For example, for a country with the same parameter values, but low destruction costs (i.e. $d = 1.5$) and intermediate patience (i.e. $\delta = 0.85$), mass killings would be harder to avoid. In particular, the zone of mass killings happening only once would be empty ($R^{**} < R^*$) and there would be mass killings by both groups for $R > R^* = 8$.

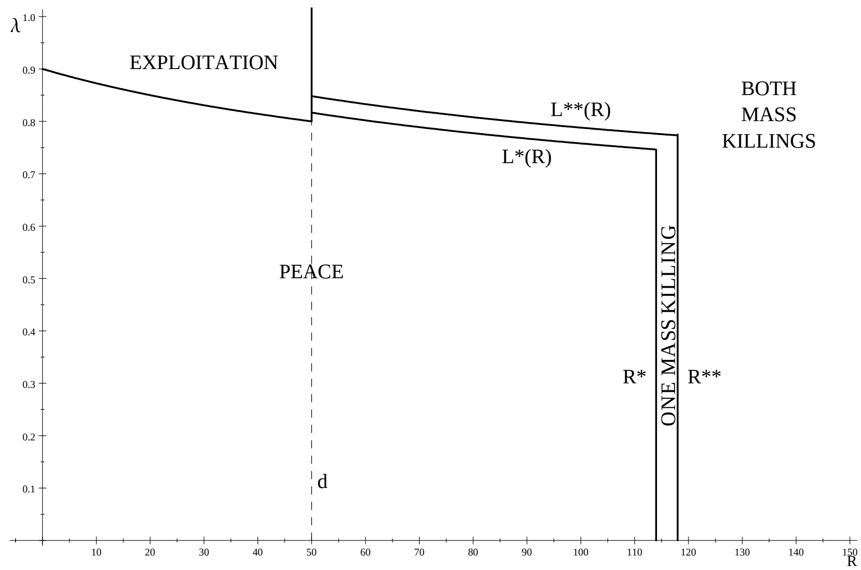

Figure 1: Zones of Peace, Exploitation, and Mass Killings (for $d = 50$, $N_i = 50$, $N_j = 50$, $\beta = 1$, $\bar{M} = 5$, and $\delta = 0.6$)

(which corresponds to the lower downward sloping line), there is peace.[11] Then there is a small corridor between R^* and $R^{**} = 118$, and between the two downward sloping $L^*(R)$ and $L^{**}(R)$ lines where only the winner of the first period conflict performs mass killings, and from then on successfully "buys off" the opponent group. For all other values of R and $\underline{\lambda}$ (i.e., to the right of R^{**} and above the $L^{**}(R)$ line), there will be mass killings of the maximum possible amount at the earliest occasion by both groups. In other words, in that zone the equilibrium path involves mass killings and then revenge mass killings at the first time power switches.

The substantive predictions of the model are contained in the next proposition:

Proposition 2: (I) *Like in the unlimited power benchmark, it continues to be true that the threshold on R above which there are mass killings in the best SPE is decreasing in N_i/N and increasing in d, β, and N, for sufficiently high δ.*

(II) *The threshold on R above which there are mass killings in the best SPE is (weakly) decreasing in $\underline{\lambda}$.*

(III) *If δ is sufficiently high, then the strictly positive value of $\overline{M}$ that maximizes the threshold for R above which there are mass killings is always interior (i.e., it is a concave function of $\overline{M}$), and the one that maximises the threshold*

[11] Note that given that in this numerical example there is $N_i = N_j$, we have $R_i^* = R_j^*$, $R_i^{**} = R_j^{**}$, $L_i^* = L_j^*$, and $L_i^{**} = L_j^{**}$, which simplifies the graphical exposition.

	Rj*	Rj**
CAP ON MASS KILLINGS		
Low maximum mass killings level (M=5)	114	118
Medium maximum mass killings level (M=10)	125	138
Medium-high maximum mass killings level (M=20)	141	183
High maximum mass killings level (M=30)	143	246
Very high maximum mass killings level (M=40)	131	380

Table 1: Effects of caps on mass killings

on R above which there are mass killings is $\overline{M} = \frac{\beta N - d}{4\beta}$.

The proof is relegated to appendix A.

Proposition 2(I) confirms the validity of the comparative statics of the benchmark proposition 1 even for the limited power case, while part (II) establishes that for third parties interested in minimizing the probability of mass killings or even the probability of war, it is never advisable to generate effective lower bounds on distributive exploitation. On the other hand, part (III) establishes that the design of optimal limits to elimination of citizens may be effective, but the desirability of how much to tighten such a constraint depends on the population size, the productivity of the economy, and the cost of war.[12]

Table 1 provides an overview of what happens for different constraints on $\overline{M}$, keeping all other parameter values as before. Given that the value of the non-resource economy (βN) equals 100, the values of R_j^* and R_j^{**} in this table correspond to the resource abundance as percentage of the non-resource economy. Hence, a value of R_j^* of, say, 200 would mean that the threshold lies at a level of resource rents being twice as large as the non-resource economy.

The effect of the level of the cap $\overline{M}$ on mass killings is ambiguous even for interior values of δ. Increasing $\overline{M}$ from a low to a medium level, makes mass killings less likely to occur, while increasing $\overline{M}$ further to a very high level results in an increase of the mass killings risk. This means that in examples like this the probability of mass killings is minimized by some interior level of $\overline{M}$, like established formally for the case of $\delta \to 1$ (see proof of Proposition 2).

Note that for many of the parameter constellations where mass killings are the most likely, i.e. for relatively high polarization and relatively low $\overline{M}$, the thresholds of R_j^* and R_j^{**} are relatively close together, meaning that with a uniform distribution of parameters, and of R in particular, the probability that

[12]Two remarks are in order. First, it goes without saying that if it was possible to costlessly enforce a complete ban of any killings, selecting $\overline{M} = 0$ would be optimal. Second, notice as well that changes to the level of $\overline{M}$ do not only affect the threshold on R above which there are mass killings, but also the level of mass killings in case they take place. Hence there could be situations with a trade-off between reducing the likelihood versus the potential extent of mass killings.

the best SPE involves mass killings on both sides (with a sequence of wars between the first and the last mass killings episode) may be on average higher than the probability of observing mass killings on one side only. Hence, for many contexts one could observe serial correlation of mass killings.

A final intuitive note about the role of the $\overline{M}$ constraint: in the world in which there is no such upper bound the game ends with the extermination of the opponent. Extermination has a cost but it grants full appropriation of the remaining surplus. The introduction of a binding cap $\overline{M}$ induces different considerations, because the victorious group will have to take into account that the game will continue with the surviving rival population. Mass killings have multiple effects: (1) for any given level of fairness, the reduction in the number of people in the other group increases the share of the surplus that the group in power will obtain, and (2) mass killings increase the probability of winning for the group in power in future wars; but (3) mass killings reduce the overall surplus size. How important this reduction is, depends on the weight of the non-produced rents. If the non-produced rents are small, the third effect dominates and mass killings are avoided. But if R is sufficiently large, mass killings become more attractive as the surplus shrinks relatively less after massacres. The non-monotonic effect of the bound on the power to kill depends on the importance of effect (2). The more the future is discounted, the more prominent will be the weight given to the more direct, immediate gains.[13]

5.4 Discussion on the risks of democratization processes

The equilibrium characterization for every pair of constraints to the exercise of power allows us to also draw some broad theoretical conclusions on the effect of a minimum fairness norm. If $\underline{\lambda}$ is very high, the group in power will not be able to impose a sufficiently advantageous share of the surplus when avoiding mass killings. Hence, too high a $\underline{\lambda}$ may induce immediate assassinations. This means that historical moments in which a group in power expects some serious reduction in their ability to extract surplus from other groups' production or from natural resources, e.g. moments of expected democratization pressures, may be the most dangerous moments in terms of mass killings incentives.

An important example of a sudden increase in $\underline{\lambda}$ is when international pressure pushes a country to initiate a process of democratization. The existing quantitative literature focuses almost exclusively on the *level* of democracy rather than the *process* of democratization. However, there is ample case study evidence available on the effects of democratization. Based on extensive historical examples, Mann (2005) argues that "murderous cleansing is modern, because it is the dark side of democracy" (2005: 2) and that "regimes newly embarked upon democratization are more likely to commit murderous ethnic cleansing than are stable authoritarian regimes" (2005: 4). Snyder (2000) makes the

[13] Putting the effects together, the cap $\overline{M}$ that makes mass killings least attractive is intermediate, at least when the players are patient enough. When δ is sufficiently low, the direct effect dominates and we may have mass killings in the best SPE for all levels of $\overline{M}$, provided that R is large enough.

same observation: "Rocky transitions to democracy often give rise to warlike nationalism and violent ethnic conflicts" (2000: 15-6).

According to Mann "ethnic cleansing diffuses along with the process of democratization" (2005: 505) and a first peak was reached already during imperialism: "Colonial cleansings did represent the first dark side of emerging modern democracy. Where settlers enjoyed de facto self-rule, these were in local reality the most democratic regimes in the world at the time" (2005: 107).[14]

Looming democratization has also been noted to have critical effects on the risks of civilian massacres by Mansfield and Snyder (2005): "The 1993 elections in Burundi–even though internationally mandated, free, and fair–intensified ethnic polarization between the Hutu and Tutsi ethnic groups, resulting in some 200,000 deaths" (2005: 5). Democratization has also been identified as contributing factor to the genocide in Rwanda (Mann, 2005, chapters 14-15). Mansfield and Snyder refer to "power sharing and pluralism as precursors to the Rwandan genocide. In Rwanda, as in Burundi, the pressures to democratize applied by the international donors that were the source of 60 percent of the Rwandan government's revenue played a central role in triggering ethnic slaughter" (2005: 255). Further, "in East Timor, a favorable vote on independence from Indonesia in an internationally mandated 1999 referendum spurred Indonesian-backed Timorese militias to unleash large-scale backlash violence, creating an international refugee crisis" (2005: 6). Regarding the case of Darfur discussed in Section 1, peace agreements in other parts of Sudan brought the expectation of "looming elections" and democratization (Straus, 2005), and this may have played a role in the decision to massacre the minority group.

Also in ex-Yugoslavia at the beginning of the 1990s the prospects of democratization and rent-sharing according to group sizes played a role in the slaughtering (Mann, 2005, chapters 12-13). "Democratization had brought Yugoslavia into the danger zone" (Mann, 2005: 376), "less than six months after the first democratic elections were held in former Yugoslav republics, the country was at war" (Woodward, 1995: 17), and soon thereafter there were the biggest massacres of civilians in recent European history. Snyder concludes that "the pathologies of incipient democratization played a central role in the nationalist conflicts in Yugoslav and the Caucasus" (2000: 250). Indeed, after the fall of communism, "partial democratization and partial increases in press freedom occurred before the outbreak of ethnic conflict in the former Yugoslavia, before the escalation in the fighting between Armenians and the former Soviet republic of Azerbaijan, and in Russia, the perpetrator of the war against the ethnic separatist Chechens" (2000: 28). Further examples where democratization fuelled incentives for ethnic massacres include among others Armenia (Mann, 2005, chapter 5-6), Kashmir (Mann, 2005: 486ff), Georgia (Snyder, 2000: 232-4), and Sri Lanka (Snyder, 2000: 275-80).

Note that our theoretical results summarized in proposition 2 are broadly consistent with the characteristics of these cases of democratization triggers:

[14] In line with the mechanism of our model, "the two ethnic groups clashed over a monopolistic economic resource, land, and most settlers did not need native labor to work it" (2005: 109).

While for countries that are either extremely natural resource poor ($R < d$) or extremely rich in natural resources ($R > R_j^{**}$) an exogenous democratization constraint is never the trigger of mass killings,[15] for the bulk of countries with low to intermediate resource abundance mass killings can occur due to a hike in $\underline{\lambda}$, and indeed many of the cases mentioned above are situations where natural resource holding would be thought of as low to intermediate.

6 Empirical Analysis

In this section we shall confront some of our predictions with data. While we keep the analysis and discussion deliberately streamlined and concise in this section, the full empirical analysis containing a critical discussion of the existing literature and various robustness checks is available in the Online Appendix.

One of the main purposes of the country level regressions in subsection 6.1 is to assess how robust the existing empirical evidence on mass killings is when important econometric issues are taken into account. Further, we want to include in the analysis several new variables, in particular on natural resource abundance, which plays a crucial role in our model, but has been largely neglected in the existing literature on mass killings.

In subsection 6.2 we study the effects of mass killings.

The ethnic group level analysis performed in subsection 6.3 examines for the first time what kind of ethnic groups are targeted in mass killings. Surprisingly, the existing literature has only studied mass killings on either a very aggregate level (i.e. with cross-country panels) or on a very disaggregate level (i.e. case studies of single countries). Studying victimization in massacres with a global panel of ethnic groups is useful, as decisions to commit massacres are strategic decisions *at the group level* (as emphasized in our model).

6.1 Country level evidence on the determinants of mass killings

We start by assessing the explanatory factors of mass killings using panel data for a cross-section of countries. For our dependent variable we rely on the most widely used dataset on mass killings, collected by the "Political Instability Task Force" (PITF) under the direction of Barbara Harff. They define mass killings as events that "involve the promotion, execution, and/or implied consent of sustained policies by governing elites or their agents – or in the case of civil war, either of the contending authorities – that result in the deaths of a substantial portion of a communal group or politicized non-communal group." By this definition, 268 country-years (3.5 percent of all observations) experience mass killings between 1955 and 2007. These killing episodes take place in 28 different countries, and include all of the most notorious historical instances of large-scale massacres like for example the ones in Sudan, Rwanda, Bosnia

[15] This is the case since for $R < d$ mass killings never take place and for $R > R^{**}$ mass killings always happen twice, independently of $\underline{\lambda}$ (see Lemma 5).

or Cambodia. Countries that have experienced mass killings differ on various dimensions emphasized in our theory. Notably, they are much more natural resource dependent, poorer and more ethnically polarized.[16] Determining whether these differences hold up in a regression analysis with various controls will be the task to which we turn below.

Our sample contains all countries that are in the Correlates of War system, i.e. all countries that have some minimum size and international recognition, and covers the years 1960-2007 (most key explanatory variables start in 1960). This leaves us in Table 2 with between 3016 and 3057 observations depending on the specification. In the Online Appendix all variables are explained in detail and summary descriptive statistics are provided.

We consider the following benchmark logit model:

$$\log\left(\frac{\mathbb{P}(Mass\_killings_{c,y}=1)}{1-\mathbb{P}(Mass\_killings_{c,y}=1)}\right)=\alpha+\mathbf{W}'_{c,y}\boldsymbol{\beta}+\mathbf{X}'_{c}\boldsymbol{\gamma}+\mathbf{Z}'_{y}\boldsymbol{\delta}, \qquad (6)$$

where the left hand side is the logarithm of the ratio of the probability of mass killings over the probability of no mass killings, with the mass killings variable varying at the country (c) and year (y) level. Coefficient α denotes the constant, $\mathbf{W}'_{cy}$ a vector of variables that vary at the country and year level, $\mathbf{X}'_c$ a vector of variables that vary at the country level, and $\mathbf{Z}'_y$ a vector of annual time dummies. $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\delta}$ are vectors of coefficients.

We use the standard controls of the existing literature (which is critically reviewed in the Online Appendix) and add natural resource abundance variables. All variables used are described in detail in Appendix B. Given that traditionally papers in the related literature on civil wars i) often use measures of natural resource abundance relative to GDP, and ii) predominantly focus on oil (see e.g. Fearon and Laitin, 2003; Collier and Hoeffler, 2004), it makes sense to use oil production as share of GDP (from British Petroleum, 2009) as main natural resource measure.

Column 1 of Table 2 (as well as the various robustness checks in the Online Appendix) strongly confirms the theoretical prediction that mass killings are the more likely the larger the role of natural resources R in the economy (significant at the 1% level). When controlling for natural resource abundance, GDP per capita proxies β and d. This variable has the expected mass killing reducing sign and is significant at the 10% level. In line with our theory, democratization in the last five years is found to increase the mass killings risk (significant at the 5% level). Further, ethnic polarization is found, as expected, to increase the risk of mass killings (significant at the 5% level). The population size N has the expected negative effect on the mass killings likelihood (significant at the 1% level).

[16] In countries with mass killings natural resource production amounts to on average 10% of their GDP while for the rest of the country sample this is 5%, their GDP per capita averages 1220 US$ as compared to the rest of the sample where it is 6150 US$, and ethnic polarization equals 0.6 compared to 0.5 in the rest of the sample. All three differences are statistically significant at the 1% level.

	Dependent variable: Mass killings incidence		
	(1)	(2)	(3)
Oil production/GDP (t-1)	6.82***		
	(1.73)		
Total resource depletion (t-1)		7.69***	
		(2.40)	
GDP per capita (t-1)	-0.14*	-0.10	-0.10
	(0.08)	(0.08)	(0.10)
Democratization (over last 5 yrs)	0.14**	0.11**	0.20***
	(0.06)	(0.06)	(0.06)
Ethnic polarization	4.56**	5.12**	4.64**
	(2.12)	(2.31)	(1.90)
Population (t-1)	-0.04***	-0.04**	-0.04***
	(0.02)	(0.02)	(0.01)
Democracy (t-1)	-0.04	-0.06	-0.05
	(0.05)	(0.06)	(0.04)
Trade / GDP (t-1)	-3.99***	-3.64***	-2.49***
	(1.30)	(1.16)	(0.88)
Civil war incidence	1.34	1.66*	1.69*
	(0.85)	(0.89)	(0.94)
Chief executive military	1.36*	1.11	1.08
	(0.79)	(0.73)	(0.71)
Population density (t-1)	2.05	0.59	1.74
	(2.60)	(3.86)	(1.10)
Mountainous Terrain	-1.82	-2.88**	-1.35
	(1.19)	(1.47)	(1.48)
Incidence mass killings (t-1)	7.66***	7.42***	7.97***
	(0.88)	(0.80)	(0.89)
Democratiz. * Oil prod.>80th percentile			-0.20***
			(0.07)
Oil prod. >80th percentile dummy			2.06***
			(0.65)
Observations	3016	3057	3016
Pseudo R-squared	0.825	0.821	0.832

Note: The unit of observation is a country in a given year. The sample covers all countries of the Correlates of War list and the years 1960-2007. Logit regressions with intercept in all columns. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the country level in parenthesis. All specifications control for unreported annual time dummies.

Table 2: Main regressions on mass killings on the country level

In column 2 a broader measure of total resource depletion per Gross National Income is used (from World Bank, 2010). This captures the total rents from energy, mineral and forest exploitation. It has a positive sign and is significant at the 1% level. The results for various other alternative measures of natural resource abundance are relegated to the Online Appendix.

Finally, in column 3 we display an additional result on democratization and mass killings. In our theory the $\underline{\lambda}$ constraint only affects the mass killings likelihood for low to intermediate levels of natural resources lying between d and R^{**} (see also the discussion at the end of subsection 5.4). The obvious difficulty of capturing this non-monotonicity in the data is that the thresholds d and R^{**} are unknown and are likely to vary widely between countries. It is reasonable to think that at least for many developing countries the destruction costs of war are relatively low.[17] In column 3 we discretize our natural resource measure and create a dummy taking a value of 1 when a country is above the 80% percentile of oil production (which corresponds to oil production accounting for 5.9% of GDP). We find that the uninteracted democratization measure has a positive coefficient (which is significant at the 1% level), and that the interaction term of democratization with the dummy of oil production above the 80th percentile has a negative sign that is significant at the 1% level.[18] These two coefficients are jointly non-significant, which implies that democratization only increases the mass killings risk for R below the 80th percentile of resource abundance, while it has no effect for the 20 percent most resource rich observations. This is of course by no means a conclusive test of this non-monotonic feature of our theory, but it is at least consistent with our predictions, provided that the d and R^{**} thresholds are relatively low.

Note that the results are very similar when restricting the sample to poor countries, i.e. to observations with below-median GDP per capita, for which d is indeed likely to be low (reported in column 8 of Table A2 in the Online Appendix). Notice also that we obtain similar results for higher thresholds. For example, when interacting democratization with oil production above the 95th percentile (corresponding to oil production accounting for above 41% of GDP) we again find the coefficient of the interaction term to be negative and significant and democratization to only increase mass killings in the 95% least oil rich countries and to have no effect for the 5% largest oil producers (reported in column 9 of Table A2 in the Online Appendix).

Let us briefly discuss the quantitative importance of the key variables of our analysis. In what follows we discuss the marginal effects based on Table 2, column 1. The unconditional baseline risk of mass killings is 3.5% and the average value of oil production in percent of GDP is 5.8% (note that all means and standard deviations of all variables are displayed in Table A4 in the Online Appendix). The marginal effect of an increase from 0% to 100% of the size of oil production with respect to GDP corresponds to an increase of 3.4 percentage

[17] Collier (1999) estimates such annual destruction costs of war for poor countries to be on average about 2 percent of GDP.

[18] Note that applying the methodology of Ai and Norton (2003) we have checked that indeed the interaction term is negative for all probability ranges.

points of mass killings risk. Put differently, while a country with all average characteristics but no oil has an annual mass killings risk of 3.3%, a country with exactly the same characteristics but an oil production value of 75% of its GDP (which is about the level for Angola, Iraq or Libya) would have a mass killings risk of 5.9%, i.e. almost double. Also our other variables of interest have sizeable effects: An increase in GDP per capita by 10000 US$ would reduce the mass killings risk by 0.7 percentage points, while moving from no change in democracy scores during the last 5 years to democratization reforms by 5 points (on a 20 point scale) in the last five year period increases the risk of mass killings by 0.4 percentage points. Further, an increase of ethnic polarization from 0% to 100% would increase the mass killings risk by 2.3 percentage points, and a population increase by 100 million people decreases the mass killings risk by 0.2 percentage points.

6.2 Country level evidence on the effects of mass killings

One feature of our theory is that natural resource rents R are not affected by mass killings, while the non-resource production decreases in the aftermath of mass killings by $\beta\overline{M}$. Hence, after mass killings the economy becomes relatively more resource dependent, with a larger share of GDP being accounted for by natural resource production.

The assumption that R is not affected by mass killings is based on the view that oil production is very capital-intensive and requires very little local labor, and in many developing countries the whole resource extraction process is carried out by big multinational firms, and the state and local population just receive taxes and royalties (see e.g. the discussion in Ploeg and Rohner, 2012).

If our assumptions are valid, we should observe that in the aftermath of mass killings the amount and value of oil production is largely unaffected, while the share of oil production in GDP should increase, given that the non-resource sectors are harmed by the killings.

To assess this, we perform a very simple analysis, where we compare the average values of various oil revenue measures in the 10 (resp. 5) years before a mass killings (MK) episode starts and compare them with the averages of the same measures in the 10 (resp. 5) years after the end of a mass killings episode. We include the same countries experiencing mass killings and the same sample period as in the regression analysis of the previous subsection.

Table 3 below displays the results. We first consider measures of resource abundance in terms of weight and current market value. Consistent with our model assumptions, the difference between the mean after mass killings and the mean before mass killings is statistically not different from zero (if anything, it seems that the values of these variables increase rather than decrease after mass killings). Then we look at three measures of resource abundance relative to the GDP, resp. Gross National Income (GNI), namely the oil production / GDP, the energy rents (as a share of GNI) and the total natural resource depletion (as a share of GNI). In line with our assumptions, there is an increase in the average values of these variables, given that the economy becomes more resource

	10 year window			5 year window		
	Mean after MK minus mean before MK	Standard error	Number observations	Mean after MK minus mean before MK	Standard error	Number observations
Oil prod.(in 100 mio. tons)	0.064	0.054	418	0.071	0.065	247
Oil prod. (in 100 bill. US$)	0.018	0.018	418	0.014	0.025	247
Oil production/GDP	0.044***	0.017	350	0.045*	0.023	211
Energy rents	0.016	0.01	311	0.031**	0.015	192
Total resource depletion	0.023**	0.01	285	0.034**	0.014	179
Fuel exports / GDP	0.101***	0.037	247	0.059	0.045	140
Trade / GDP	0.066***	0.025	392	0.063**	0.03	235

Note: Significance levels *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Comparing oil abundance before and after mass killings

dependent (in five out of six comparisons the difference is statistically significant, and only for energy rents in a 10 year window the significance threshold is not quite reached).

One of the reasons why one could doubt our assumption of natural resource production being unaffected by mass killings is that it may be conceivable that in the aftermath of massacres countries suffer from export embargoes. While this may have been the case in a few exceptions, it does not seem to be the rule. As shown for the last two variables in the table, both Fuel exports / GDP and Trade / GDP if anything seem to increase, rather than decrease on average in the years following a mass killings episode.

There is a general explanation for why sanctions may not be applied once the killing is over: As established in the literature on economic sanctions, sanctions are seen as coercive tools (i.e., meant to change the behavior of a target), rather than punitive tools (i.e., meant to punish past behavior). See e.g. Pape (1997) and Hufbauer et al. (2009).

There are also important case studies that we can now mention in support of the above findings. Consider for example the case of Sudan[19], a place with multiple mass killings in recent history. In the midst of a civil war between the central government and the SPLA in the south that had been raging since 1983, characterized by large-scale killing of civilians, in 1999 Sudan started producing and exporting oil, which significantly reduced Khartoum's international isolation (International Crisis Group, 2002). The opening of oil fields pushed some European governments to adopt a friendlier attitude towards Khartoum and brought about deeper economic ties with China and Malaysia. In addition, Khartoum's cooperation with US counter-terrorism efforts (in particular after the September 11th attacks) determined a substantial improvement of its relations with Washington. In the late 1990s and early 2000s, Khartoum resorted to scorched-earth tactics to displace populations residing around existing and potential oil fields, thus making these areas more defensible. The Sudan case thus illustrates how it is not necessarily the case that large scale victimization of

[19] See e.g. the discussion in SIPRI (2000, 2004).

civilians (in particular if occurred in the past) would prevent the perpetrating country from attracting investments by international energy companies.

Another important example is Iraq. As one can see from the oil data we use from British Petroleum (2009), Iraq's oil production peaked in the five years immediately after crushing the Kurdish rebels in 1975. Those years were characterized by large-scale deportations of Kurds[20] from border areas and oil-rich Kirkuk. Oil production plummeted during the Iran-Iraq war (Baghdad could not export the bulk of its oil via the Basra port) but peaked again at the end and after the war (1988/1989), in spite of new mass killings of Kurds in 1987-1988.[21]

6.3 Ethnic group level evidence

While in subsection 6.1 we carried out an analysis at the country year level, here we focus on a panel at the ethnic group year level. This allows us to study what kinds of ethnic groups become victims of military massacres of civilians.

As a starting point we use the "Geo-referencing of ethnic groups" (GREG) dataset (Weidmann, Rod and Cederman, 2010). Relying on maps from the classical Soviet Atlas Narodov Mira from the 1960s, GREG contains a geo-referenced dataset with the coordinates of the group boundaries of 929 ethnic groups. One major advantage of this very comprehensive dataset is that it contains information on the geographical location of groups, which enables us to merge it with other geo-referenced group-level data using Geographical Information Systems (GIS), while this information on group boundaries is missing for the main competing datasets on ethnic groups.[22]

One obvious limitation of this data is that it is dated, which implies that in some instances the group boundaries are not fully accurate anymore in recent times, particularly because group boundaries can change in the aftermath of civil wars. However, this has both advantages and disadvantages. The fact that the data is dated lowers accuracy and hence adds noise to our estimations, which biases the magnitude of coefficients and the significance levels downwards, while there seems to be no other obvious bias of the results. This means that using GREG will tend to bias the results against us and making them appear *less* strong than they are in reality. The advantage of using group boundaries from the 1960s is that this limits concerns of reversed causality, as the massacres we study take place three decades later. Thus, what we lose in terms of accuracy we gain in terms of identification.

As dependent variable, we focus on a given ethnic group in a given year being the target of military massacres of civilians. The only high-quality measure of

[20] It is estimated that as many as 1,400 villages may have been destroyed after the war, between 1975 and 1978 – see McDowall (2004).

[21] A common opinion is that the international community was slow in accusing Iraq of mass killings, and turned a blind eye (see Hiltermann, 2007) because it was a US/west ally. Iraqi oil production was hit by sanctions only when Saddam Hussein became an international villain by occupying Kuwait.

[22] Throughout the database construction we use the country borders from the time-varying, geo-referenced "CShapes" dataset (Weidmann, Kuse, and Gleditsch, 2010).

massacres of civilians at the ethnic group level we are aware of is from the "Minorities at Risk" (2009, MAR) project. MAR contains a panel of all ethnic minority groups that suffer from threats or discrimination. Note that 23% of all groups from GREG are included in MAR, and 4.3% of the observations in MAR are coded as being subject to military massacres of civilians. Our dependent variable of mass killings victimization at the group level is only available for the years 1996-2003, which leaves us with a short panel.

If we were to restrict our analysis to only groups included in MAR our results could suffer from sample selection as only groups at risk are in MAR and all the fully peaceful and well-treated groups are excluded. Given that MAR gives a comprehensive account of persecuted groups it is safe to assume that all groups who have been subject to massacres are included in MAR. Hence it is reasonable to include the full sample of groups in GREG in the analysis and code as having no massacres all groups absent from MAR. This is what we do in Table 4 where we have a sample of 7098 observations (resp., 1582 observations when country fixed effects are included). In the Online Appendix we also perform additional regressions where we restrict the analysis to only groups in MAR, which results in a drop of sample size to 1299 observations, but allows us to add additional control variables that are only available in MAR.

Our main independent variable is the ethnic group's petrol abundance, which is captured by the percentage of a group's territory covered with oil and gas. To the best of our knowledge we are the first ones to construct this measure. Using GIS software (ArcGIS) we have matched the data from GREG on the geographical boundaries of ethnic groups with the geo-referenced petroleum dataset (PETRODATA) from Lujala, Rod and Thieme (2007), which tells us where oil fields lie. Combining this information, we have computed a variable measuring which part of the territory occupied by a given ethnic group contains oil. This yields a relatively precise measure of how petrol-rich the homelands of a given ethnic group are. According to our theory we expect groups that live in petrol-rich areas, but are economically relatively unproductive, to be attractive targets for the ruling groups in their country. By attacking such groups, the group in power can substantially increase its share of natural resource rents, but only marginally decreases the production output.

Several other important independent variables are included in our dataset. Using the geo-referenced DIADATA dataset on the location of diamonds (from Gilmore et al., 2005), we have created a dummy variable on whether a given ethnic group has diamond production on its territory.[23] Further, we include several geographic and demographic control variables on the ethnic group level: The group's relative population size (using Cederman, Buhaug and Rod, 2009), the group's geographic concentration, the number of countries where the same ethnic group is present (both computed with the help of the GREG data), the share of the group's territory covered by mountains, and the distance from the

[23] There is such a huge variance in production scale among the different mining observations —and production quantities are not included in DIADATA— that it is safest to code a dummy variable of production, which is also the approach chosen by Lujala, Gleditsch and Gilmore (2005).

group territory to its country's capital (both from Cederman, Buhaug and Rod, 2009). In addition, we have constructed variables capturing the group's economic potential: First, we have included the percentage of the group's territory with high-quality fertile soil, which has been constructed based on the Harmonized World Soil Database (Fischer et al., 2008). Second, we have included the average light intensity during night in the ethnic group's territory, measured with the help of meteorologic satellites. This data is from the National Oceanic and Atmospheric Administration (2010), and have been used in recent research as a proxy for economic activity (see e.g. Henderson, Storeygard and Weil (2012) and Rohner, Thoenig and Zilibotti (2013)). Finally, we have included a dummy variable taking a value of 1 for the groups that have in the same year been involved in civil conflict (from Cederman, Buhaug and Rod (2009)). In Appendix B all variables are explained in detail.

In addition to these ethnic group-specific variables we control for exactly the same country-level variables as in the most inclusive specification of the country-level regressions (column 6 of Table A1 in the Online Appendix).[24] To account for unobserved heterogeneity, all columns have robust standard errors that are allowed to be clustered at the country level.

We consider the following benchmark logit model for the ethnic group level regressions:

$$\log\left(\frac{\mathbb{P}(Massacres\_civilians_{e,y}=1)}{1-\mathbb{P}(Massacres\_civilians_{e,y}=1)}\right)=\alpha+\mathbf{U}'_{e,y}\boldsymbol{\beta}+\mathbf{V}'_{e}\boldsymbol{\gamma}+\mathbf{W}'_{c,y}\boldsymbol{\delta}+\mathbf{X}'_{c}\boldsymbol{\zeta}+\mathbf{Z}'_{y}\boldsymbol{\eta}, \tag{7}$$

where the left hand side is the logarithm of the ratio of the probability of massacres of civilians over the probability of no massacres of civilians, with the massacres of civilians variable varying at the ethnic (e) and year (y) level. Coefficient α denotes the constant, $\mathbf{U}'_{e,y}$ a vector of variables that vary at the ethnic and year level, $\mathbf{V}'_{e}$ a vector of variables that vary at the ethnic level, $\mathbf{W}'_{cy}$ a vector of variables that vary at the country (c) and year level, $\mathbf{X}'_{c}$ a vector of variables that vary at the country level, and $\mathbf{Z}'_{y}$ a vector of annual time dummies. $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, $\boldsymbol{\delta}$, $\boldsymbol{\zeta}$, and $\boldsymbol{\eta}$ are vectors of coefficients. The coefficients of interest are the ones corresponding to the main ethnic group level variables mentioned above.

Like in the country level regressions above, we code in Table 4 the military massacres of civilians as dummy variable, taking a value of 1 if in a given year a given ethnic group has been subject to massacres, and run logit regressions.[25] In column 1 it is found that groups that are more petrol and diamond rich and

[24] The only exception is that we control for democratization in the last year rather than democratization in the last five years. This helps to prevent a further drop in the sample size, as in some of the columns of Table 4 and of Table A3 in the Online Appendix the sample size is already critically small. Note however that when controlling for democratization over the last 5 year period we obtain very similar results, and our main variables of interest (percentage of group's territory with oil and gas, resp. with oil) are statistically significant in all of the specifications.

[25] In the Online Appendix we also present results when the dependent variable is constructed as ordinal scale variable.

	Dependent variable: Victimization by military massacres of civilians	
	(1)	(2)
% of group's terr. with oil & gas	2.11**	3.90*
	(0.91)	(2.13)
Group's diamond prod. dummy	1.33*	2.25*
	(0.75)	(1.26)
Group's soil quality	3.68**	4.37***
	(1.61)	(1.43)
Group's pop. / Country pop. (t-1)	-4.51*	-3.75*
	(2.38)	(2.13)
Group geographic concentration	-1.46***	-3.83**
	(0.53)	(1.50)
Group co-ethnics abroad	0.00	0.62***
	(0.17)	(0.21)
Group's share of mountain. terr.	1.84**	1.86*
	(0.82)	(1.01)
Group's distance to capital	-0.52	-1.03
	(0.67)	(0.69)
Group's satellite light intensity	0.10	-1.24
	(0.48)	(1.98)
Group involved in civil conflict	2.63***	3.88***
	(0.82)	(0.66)
Estimator	Logit	Cou.FE Log.
Observations	7098	1582
Pseudo R-squared	0.519	0.637

Note: The unit of observation is an ethnic group in a given year. The sample covers all ethnic groups from the Geo-Referenced Ethnic Groups (GREG) list and the years 1996-2003. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Column 1 has robust standard errors clustered at the country level in parenthesis, while in column 2 the estimator used does not allow for clustering. All specifications include intercept, annual time dummies, and all the country-level independent variables of the (most extensive) column 6 of the Online Appendix Table A1 (not reported).

Table 4: The determinants of victimization of ethnic groups

that occupy valuable soils are significantly more likely to be targeted in terms of mass killings. This is in line with the predictions of our model on resource abundance fuelling the mass killings risk.

Further, we find that a given ethnic group is significantly more at risk if it is relatively small. This is also consistent with our theory: remember that we control for the country-level variables of Table 2, including ethnic polarization. Hence, the fact that –for a given level of ethnic polarization– smaller groups are more often targeted, is consistent with the feature of our model that smaller groups are more likely to be defeated in war.

In column 2 we include country fixed effects, which implies that our results are now entirely driven by variation between ethnic groups within the same country, and by variation over time. In this demanding specification as well all results from the previous column are confirmed and all the previously significant variables remain statistically significant.

Let us briefly discuss the quantitative importance of the effects of our main variables, based on marginal effects for the logit regression of column 1. The baseline average risk for an ethnic group to be massacred is 1% in a given year, and an average group has 6.2% of its territory covered by oil and gas wells. The marginal effect of a group moving from zero oil to having oil fields under its whole territory would be an increase of 1.7 percentage points in the risk of being subject to massacres. Put differently, an ethnic group with all average characteristics but no oil has a risk of being massacred of 0.9%, while the same group would face a massacre risk of 2.6% if its whole territory was covered with oil and gas, which corresponds to almost tripling the risk of massacres. Further, having diamonds increases the risk of being the target of mass killings by 1 percentage point. Moreover, a group having high-quality soil all over its land, rather than populating a completely deserted spot, faces a 2.9 percentage points larger risk of being massacred. Finally, increasing the group's share of the country population by 10 percentage points would reduce its risk of being massacred by 0.4 percentage points.

7 Concluding remarks

We have established that when a country divided in identifiable groups is natural resource abundant and the destructive expected costs of civil war are not overwhelmingly high, dynamic incentives to kill minority groups emerge. Moreover, such material dynamic incentives to eliminate opponents can also be enhanced when a democratization process or some other source of increasing institutional constraints to unfair distributions arise, when the productivity of labor is low and when the society is ethnically polarized.

The empirical results confirm the theoretical predictions. In contexts displaying a large abundance of natural resources, and in particular petrol and diamonds, the risk of mass killings is substantially larger. While we do find that the absolute amounts of natural resources matter, the results also indicate that the relative weight of natural resources with respect to the non-resource production counts. Hence, for a given amount of oil in the ground the mass killings risk in a country can be substantially reduced when a productive and skill-intensive economy is built.

The model could be easily extended in several interesting directions. One particularly interesting extension that could be considered relates to the description of economic activities: it is for example realistic to allow for decreasing returns in agricultural production. In Rwanda, for example, the really important contestable resource is productive land, and decreasing returns from agricultural production could explain the mass killings incentives.[26] The predictions of such an extension would be consistent with our empirical finding that ethnic groups with homelands covered with very fertile land face a substantially larger risk of being massacred. Another potentially fruitful extension could be to introduce capital in the production function, to analyze the comparative incentives of elites to destroy the asset holdings of powerless groups rather than killing them.

The logic of our model could also be useful to capture the essential motivations behind the mass killings of native American tribes: the American Indians were holding off the large-scale development and exploitation of the great resources of the West, and their traditional use of the land was considered much less efficient than the alternative, hence the elimination of them had both a large impact on the amount of natural resources that it became possible to extract and on the average productivity. To capture this story fully in the model, one would have to attribute a lower β_i to the Indians and consider R as $R(N_i)$, capturing the fact that the amount of productive land and other resources exploitable by the U.S. was considered decreasing in the size of Indian occupied territories. Only when the Indians accepted (or were forced to accept) the clear discrimination of reservations (low λ) the mass killings stopped.

Finally, we believe that our insights about the potential drawbacks of institutional constraints and direct threats of intervention could be useful for future research on optimal intervention policies, a theoretical literature recently initiated by Kydd and Straus (2013).

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Appendix A: Proofs

Proof of Lemma 5

Express the value function for a given player k with population size N_k, and population size of the opponent h being N_h, as $V_k(N_k, N_h)$. The payoff of i from rebelling is:

$$\frac{N_i}{N}\left[S - d + \delta V_i(N_i, N_j - \overline{M})\right] + \frac{N_j}{N}\delta V_i(N_i - \overline{M}, N_j),$$

where

$$V_i(N_i, N_j - \overline{M}) = \frac{N_i}{N - \overline{M}}\left[S - \beta\overline{M} - d + \delta V_i(N_i, N_j - \overline{M})\right] + \frac{N_j - \overline{M}}{N - \overline{M}}\delta V_i(N_i - \overline{M}, N_j - \overline{M}), \tag{8}$$

and

$$V_i(N_i - \overline{M}, N_j) = \frac{N_i - \overline{M}}{N - \overline{M}}\left[S - \beta\overline{M} - d + \delta V_i(N_i - \overline{M}, N_j - \overline{M})\right] + \frac{N_j}{N - \overline{M}}\delta V_i(N_i - \overline{M}, N_j), \tag{9}$$

and

$$V_i(N_i - \overline{M}, N_j - \overline{M}) = \frac{N_i - \overline{M}}{N - 2\overline{M}}\frac{S - 2\beta\overline{M} - d}{1 - \delta}. \tag{10}$$

Plugging (10) in equation (8) and solving it recursively, we obtain:

$$V_i(N_i, N_j - \overline{M}) = \frac{N_i\left[S - \beta\overline{M} - d\right](N - 2\overline{M})(1 - \delta) + \delta(N_j - \overline{M})(N_i - \overline{M})(S - 2\beta\overline{M} - d)}{(1 - \delta)(N - 2\overline{M})\left[N - \overline{M} - \delta N_i\right]}. \tag{11}$$

Similarly, plugging equation (10) in equation (9) and solving it recursively, we obtain:

$$V_i(N_i - \overline{M}, N_j) = (N_i - \overline{M})\frac{(S - \beta\overline{M} - d)(N - 2\overline{M})(1 - \delta) + \delta(N_i - \overline{M})(S - 2\beta\overline{M} - d)}{(N - \overline{M} - \delta N_j)(N - 2\overline{M})(1 - \delta)}. \tag{12}$$

Plugging these expressions into the payoff function for rebellion, the peace IC condition for i becomes:

$$\begin{aligned}
& N_i(S - d) \\
& + N_i\delta\frac{\left[S - \beta\overline{M} - d\right]\left\{(1 - \delta)N_i(N - 2\overline{M}) + \delta(N_j - \overline{M})(N_i - \overline{M})\right\} - \delta(N_j - \overline{M})(N_i - \overline{M})\beta\overline{M}}{(1 - \delta)(N - 2\overline{M})\left[N - \overline{M} - \delta N_i\right]} \\
& + N_j\delta(N_i - \overline{M})\frac{\left[(S - \beta\overline{M} - d)\left\{(N - 2\overline{M})(1 - \delta) + \delta(N_i - \overline{M})\right\} - \delta(N_i - \overline{M})\beta\overline{M}\right]}{(N - \overline{M} - \delta N_j)(N - 2\overline{M})(1 - \delta)} \\
= \; & \lambda N_i\frac{S}{1 - \delta}.
\end{aligned}$$

Now solve in terms of λ:

$$\begin{aligned}\lambda_j^* &= \frac{S-d}{S}(1-\delta) \\ &+\delta\frac{\left[S-\beta\overline{M}-d\right]\left\{(1-\delta)N_i(N-2\overline{M})+\delta(N_j-\overline{M})(N_i-\overline{M})\right\}-\delta(N_j-\overline{M})(N_i-\overline{M})\beta\overline{M}}{S(N-2\overline{M})\left[N-\overline{M}-\delta N_i\right]} \\ &+\frac{N_j\delta(N_i-\overline{M})}{SN_i}\frac{\left[(S-\beta\overline{M}-d)\left\{(N-2\overline{M})(1-\delta)+\delta(N_i-\overline{M})\right\}-\delta(N_i-\overline{M})\beta\overline{M}\right]}{(N-\overline{M}-\delta N_j)(N-2\overline{M})}. \qquad (13)\end{aligned}$$

Note that $\partial\lambda_j^*/\partial R>0$, like in the unlimited mass killings power case.

This expression for λ_j^* will later on be plugged into j's peace payoff function $\frac{(1-\frac{N_i}{N}\lambda_j^*)S}{1-\delta}$. The payoff for j of deviating and performing mass killings is $S+\delta V_j(N_i-\overline{M},N_j)$, where

$$\begin{aligned}V_j(N_i-\overline{M},N_j) &= \frac{N_j}{N-\overline{M}}\left(S-\beta\overline{M}-d+\delta V_j(N_i-\overline{M},N_j)\right) \\ &+\frac{N_i-\overline{M}}{N-\overline{M}}\delta\frac{N_j-\overline{M}}{N-2\overline{M}}\frac{S-2\beta\overline{M}-d}{1-\delta}.\end{aligned}$$

Solving this recursively, we obtain

$$V_j(N_i-\overline{M},N_j)=\frac{N_j(S-\beta\overline{M}-d)(1-\delta)(N-2\overline{M})+\delta(N_i-\overline{M})(N_j-\overline{M})(S-2\beta\overline{M}-d)}{(1-\delta)(N-\overline{M}-\delta N_j)(N-2\overline{M})}.$$

Our condition for j preferring peace to mass killings corresponds to

$$\frac{(1-\frac{N_i}{N}\lambda_j^*)S}{1-\delta}>S+\delta V_j(N_i-\overline{M},N_j).$$

Plugging the expressions for λ_j^* and $V_j(N_i-\overline{M},N_j)$ into the condition above yields after reformulation condition (14):

$$R<R_j^*\equiv\frac{\begin{array}{c}d\frac{N_i}{N}(1-\delta)(N-2\overline{M})(N-\overline{M}-\delta N_j)\left[N-\overline{M}-\delta N_i\right] \\ +\delta(N-\overline{M}-\delta N_j)\frac{N_i}{N}\begin{pmatrix}\left[\beta\overline{M}+d\right](1-\delta)N_i(N-2\overline{M}) \\ +\left[2\beta\overline{M}+d\right]\delta(N_j-\overline{M})(N_i-\overline{M})\end{pmatrix} \\ +\delta(\beta\overline{M}+d)\left[N-\overline{M}-\delta N_i\right]\left\{\begin{array}{c}(N-2\overline{M})(1-\delta)\frac{N_j}{N}\left[N+N_i-\overline{M}\right] \\ +\delta(N_i-\overline{M})\left[(N_j-\overline{M})+\frac{N_j}{N}(N_i-\overline{M})\right]\end{array}\right\} \\ +\delta^2(N_i-\overline{M})\beta\overline{M}\left[N-\overline{M}-\delta N_i\right]\left\{(N_j-\overline{M})+\frac{N_j}{N}(N_i-\overline{M})\right\}\end{array}}{(1-\delta)^2(N-2\overline{M})\frac{N_i}{N}(N-\overline{M})^2+\delta^2(1-\delta)(N_i-\overline{M})N_i(N_j-\overline{M})}-\beta N. \qquad (14)$$

Note that both the denominator and the numerator of the fraction are unambiguously positive, and that the condition for peace is unambiguously less likely to hold for large R.

Note that it can be easily shown that for some parameters $R_j^*>d$ holds (in which case the set $\left[d,R_j^*\right]$ is non-empty), hence making case (i) of the lemma non vacuous. For other parameter values $R_j^* \leq d$. In particular, when δ is small enough we have $R_j^* < d$ (e.g. when $\delta = 0$, then $R_j^* \equiv d - \beta N < d$), while for large enough δ the inequality $R_j^* > d$ holds (e.g. in the limit when $\delta \to 1$ then R_j^* tends towards infinity).

For small enough values of $\underline{\lambda}$ (less than λ_j^*), the above computations of the two thresholds λ_j^* and R_j^* are all we need for the characterization of the region of peace.

Let us now consider the case in which $\underline{\lambda}$ binds. We know that i will be peaceful when offered $\underline{\lambda}$. The payoff for j of peace is $\left(1 - \frac{N_i}{N}\underline{\lambda}\right)\frac{S}{1-\delta}$. The payoff for j of mass killings is $S + \delta V_j(N_i - \overline{M}, N_j)$, where

$$\begin{aligned} V_j(N_i - \overline{M}, N_j) &= \frac{N_j}{N - \overline{M}}\left(S - \beta\overline{M} - d + \delta V_j(N_i - \overline{M}, N_j)\right) \\ &\quad + \frac{N_i - \overline{M}}{N - \overline{M}}\delta\frac{N_j - \overline{M}}{N - 2\overline{M}}\frac{S - 2\beta\overline{M} - d}{1 - \delta}. \end{aligned}$$

Solving this expression recursively and simplifying it yields:

$$V_j(N_i - \overline{M}, N_j) = \frac{N_j\left(S - \beta\overline{M} - d\right)(N - 2\overline{M})(1-\delta) + \delta(N_i - \overline{M})(N_j - \overline{M})(S - 2\beta\overline{M} - d)}{(N - \overline{M} - \delta N_j)(N - 2\overline{M})(1-\delta)}.$$

Hence, peace will be preferred by j iff:

$$\left(1 - \frac{N_i}{N}\underline{\lambda}\right)\frac{S}{1-\delta} > S + \delta\frac{N_j\left(S - \beta\overline{M} - d\right)(N - 2\overline{M})(1-\delta) + \delta(N_i - \overline{M})(N_j - \overline{M})(S - 2\beta\overline{M} - d)}{(N - \overline{M} - \delta N_j)(N - 2\overline{M})(1-\delta)}.$$

After reformulation this condition becomes:

$$\underline{\lambda} < L_j^* \equiv \frac{\delta N}{N_i}\left(1 - \frac{N_j\left(S - \beta\overline{M} - d\right)(N - 2\overline{M})(1-\delta) + \delta(N_i - \overline{M})(N_j - \overline{M})(S - 2\beta\overline{M} - d)}{(N - \overline{M} - \delta N_j)(N - 2\overline{M})S}\right). \tag{15}$$

Note that the peace condition is harder to satisfy when $\underline{\lambda}$ increases. Notice also that the right-hand-side is unambiguously decreasing in R, meaning that peace is only achievable when R is small enough.

The construction of the third threshold function $L_j^*(R)$ obtained above completes the proof of part (i).

(ii) Consider now what happens when $R > R_j^*$ and/or $\underline{\lambda} > \max\left\{\lambda_j^*, L_j^*\right\}$, where R_j^* is defined in expression (14), λ_j^* is defined in expression (13), and L_j^* in expression (15). The best SPE definitely involves war in the first period, due to the shadow of mass killings by j. If group j wins it commits mass killings $\overline{M}$. If group i wins it commits mass killings $\overline{M}$ iff $R > R_i^*$ and/or $\underline{\lambda} > \max\left\{\lambda_i^*, L_i^*\right\}$, while for $R \leq R_i^*$ and $\underline{\lambda} \leq \max\left\{\lambda_i^*, L_i^*\right\}$ the best SPE involves peace ever after. Consider now the case where mass killings were perpetrated by the winner. Call $h = i, j$ that winning group, and let us find the condition under which group h, after killing $\overline{M}$ members of group k, is able to buy peace forever after. Compute

$\widehat{\lambda}_h$ necessary for such an outcome. The payoff for k from peace from that time on is

$$\lambda_h \frac{N_k - \overline{M}}{N - \overline{M}} \frac{S - \beta\overline{M}}{1 - \delta}.$$

Group k knows that if it rebels it will trigger a phase with war in every future period, and where group h cannot do any more mass killings in any period, as h has already reached its upper bound $\overline{M}$, and where at the first occasion when k reaches power it will commit mass killings of $\overline{M}$. Hence, the payoff for k from rebellion is:

$$W_k(N_k - \overline{M}, N_h) = \frac{N_k - \overline{M}}{N - \overline{M}} \left(S - \beta\overline{M} - d + \delta \frac{N_k - \overline{M}}{N - 2\overline{M}} \frac{S - 2\beta\overline{M} - d}{1 - \delta} \right) + \frac{N_h}{N - \overline{M}} \delta W_k(N_k - \overline{M}, N_h).$$

Solving this recursively and reformulating it yields:

$$W_k(N_k - \overline{M}, N_h) = (N_k - \overline{M}) \frac{S - \beta\overline{M} - d + \delta \frac{N_k - \overline{M}}{N - 2\overline{M}} \frac{S - 2\beta\overline{M} - d}{1 - \delta}}{N - \overline{M} - \delta N_h}.$$

Putting equal the peace and rebellion payoffs pins down the indifference $\widehat{\lambda}_h$:

$$\widehat{\lambda}_h = (N - \overline{M}) \frac{(N - 2\overline{M})(S - \beta\overline{M} - d)(1 - \delta) + \delta(N_k - \overline{M})(S - 2\beta\overline{M} - d)}{(N - 2\overline{M})(N - \overline{M} - \delta N_h)(S - \beta\overline{M})}.$$

The final step is to compute the condition under which h is willing indeed to offer such a $\hat{\lambda}_h$. With peace h obtains:

$$\left(1 - \widehat{\lambda}_h \frac{N_k - \overline{M}}{N - \overline{M}}\right) \frac{S - \beta\overline{M}}{1 - \delta}.$$

A deviation to exploitation yields to h: $S - \beta\overline{M} + \delta W_h(N_k - \overline{M}, N_h)$, where

$$W_h(N_k - \overline{M}, N_h) = \frac{N_h}{N - \overline{M}} \left(S - \beta\overline{M} - d + \delta W_h(N_k - \overline{M}, N_h)\right) + \frac{N_k - \overline{M}}{N - \overline{M}} \delta \frac{N_h - \overline{M}}{N - 2\overline{M}} \frac{S - 2\beta\overline{M} - d}{1 - \delta},$$

which becomes, after reformulation:

$$W_h(N_k - \overline{M}, N_h) = \frac{N_h \left(S - \beta\overline{M} - d\right) + (N_k - \overline{M}) \delta \frac{N_h - \overline{M}}{N - 2\overline{M}} \frac{S - 2\beta\overline{M} - d}{1 - \delta}}{N - \overline{M} - \delta N_h}.$$

Putting these expressions together, we find after reformulation that peace is sustainable iff

$$R < R_h^{**} \equiv \frac{\begin{array}{c}\beta\overline{M}(N_k - \overline{M}) \left((N_h - \overline{M})(1 - 2\delta(1 - \delta)) + (N_k - \overline{M})\right) \\ +d\left((N_k - \overline{M})\left((N - 2\overline{M}) + \overline{M}\delta(1 - \delta)\right) + \delta(1 - \delta) N_h (N_h - \overline{M})\right)\end{array}}{(1 - \delta)(N_k - \overline{M})\left((N - 2\overline{M}) - \delta(N_h - \overline{M})\right)} - \beta N.$$

Note that one can easily show that there are parameter values for which the interval $[R_h^*, R_h^{**}]$ is not empty: e.g. for the special case of $\delta = 0$ we have $R_j^* \equiv d - \beta N < R_h^{**} \equiv d + \beta\overline{M} - \beta N$.

Now we can also derive the analogous conditions when $\underline{\lambda}$ is binding. In particular, peace is sustainable iff

$$\left(1-\underline{\lambda}\frac{N_k-\overline{M}}{N-\overline{M}}\right)\frac{S-\beta\overline{M}}{1-\delta} > S-\beta\overline{M}+\delta\frac{N_h\left(S-\beta\overline{M}-d\right)+(N_k-\overline{M})\delta\frac{N_h-\overline{M}}{N-2\overline{M}}\frac{S-2\beta\overline{M}-d}{1-\delta}}{N-\overline{M}-\delta N_h},$$

which becomes

$$\underline{\lambda} < L_h^{**} \equiv \delta\frac{N-\overline{M}}{N_k-\overline{M}}\left(1-\frac{N_h\left(S-\beta\overline{M}-d\right)(1-\delta)+(N_k-\overline{M})\delta\frac{N_h-\overline{M}}{N-2\overline{M}}(S-2\beta\overline{M}-d)}{(S-\beta\overline{M})(N-\overline{M}-\delta N_h)}\right).$$

Proof of Proposition 2

(I) The effects of R on the probability of mass killings are obvious, since mass killings are surely avoided only if $R < R_j^*$, defined in (14).

For performing comparative statics with respect to d and β we can reformulate the inequality $R < R_j^*$ as follows:

$$R < \frac{d\left(\begin{array}{c}\frac{N_i}{N}(N-\overline{M}-\delta N_j)\left\{\begin{array}{c}(1-\delta)(N-2\overline{M})(N-\overline{M})\\+\delta^2(N_i-\overline{M})(N_j-\overline{M})\end{array}\right\}\\+\delta\left[N-\overline{M}-\delta N_i\right]\left\{\begin{array}{c}(1-\delta)(N-2\overline{M})\frac{N_j}{N}\left[N+N_i-\overline{M}\right]\\+\delta(N_i-\overline{M})\left[(N_j-\overline{M})+\frac{N_j}{N}(N_i-\overline{M})\right]\end{array}\right\}\end{array}\right)}{(1-\delta)^2(N-2\overline{M})\frac{N_i}{N}(N-\overline{M})^2+\delta^2(1-\delta)(N_i-\overline{M})N_i(N_j-\overline{M})}$$
$$+\beta(\frac{\delta\overline{M}\left(\begin{array}{c}(N-\overline{M}-\delta N_j)\frac{N_i}{N}\left\{\begin{array}{c}(1-\delta)N_i(N-2\overline{M})\\+2\delta(N_j-\overline{M})(N_i-\overline{M})\end{array}\right\}\\+\left[N-\overline{M}-\delta N_i\right]\left\{\begin{array}{c}(1-\delta)(N-2\overline{M})\frac{N_j}{N}\left[N+N_i-\overline{M}\right]\\+2\delta(N_i-\overline{M})(N_j-\overline{M}+\frac{N_j}{N}(N_i-\overline{M}))\end{array}\right\}\end{array}\right)}{(1-\delta)^2(N-2\overline{M})\frac{N_i}{N}(N-\overline{M})^2+\delta^2(1-\delta)(N_i-\overline{M})N_i(N_j-\overline{M})}-N).$$

The right-hand-side is unambiguously increasing in d, which implies that peace without mass killings is easier to achieve when the destruction costs of war are larger.

The effect of an increase in β is a priori ambiguous, as β multiplies a first, positive and a second, negative term. For high enough δ the first term is always larger than the second (i.e. in the limit when $\delta \to 1$ the first term tends toward infinity), in which case larger β makes peace easier to sustain, as in the unconstraint power case.

Further, the condition for peace is more likely to hold for very patient than for very impatient groups. Given that the condition above contains terms with higher-order polynomials of δ, we cannot express an analytical threshold in terms of δ. However, we can study the limit cases. In particular, in the limit when $\delta \to 1$ the right-hand-side goes towards infinity, and the peace condition always holds. In contrast, when $\delta = 0$, the peace condition simplifies to $R < R_j^* \equiv d - \beta N$, which never holds, as long as $d < S$.

Note that in the limit of $\delta \to 1$ the right-hand-side is also increasing in N and decreasing in N_i/N.

(II) This is the case, as both $\underline{\lambda} < L_h^*$ and $\underline{\lambda} < L_h^{**}$ are more likely to hold for small $\underline{\lambda}$.

(III) In the limit when $\delta \to 1$ threshold R_j^* (and hence the likelihood of peace) is a concave function of $\overline{M}$ and the peace likelihood is at maximum for $\overline{M} = \frac{\beta N - d}{4\beta}$.

Appendix B: Data Description

This Appendix B describes the data used in section 6. Descriptive summary statistics for all variables are provided in the Online Appendix.

Variables on the country level

Chief Executive is Military Officer: Dummy variable taking a value of 1 if the chief executive has an officer rank. From Beck et al. (2001), updated version 2007.

Civil War Incidence: Dummy taking a value of 1 when there is a civil war taking place. From Gleditsch and Ward (2007).

Democracy: Polity scores ranging from -10 (strongly autocratic) to +10 (strongly democratic). From Polity IV (2009).

Democratization (over last 5 years): (Absolute) change in the democracy scores between $t-1$ and $t-5$ (see above).

Energy rents: Rents from energy depletion in percent of Gross National Income at market prices. Energy depletion covers crude oil, natural gas, and coal (hard and lignite). Rent = (Production Volume) x (International Market Price - Average Unit Production Cost). From World Bank (2010).

Ethnic Polarization: Continuous measure going from 0 (minimum) to 1 (maximum). From Reynol-Querol (2009).

Fuel exports / GDP: Fuel exports per GDP. The 12 observations (=0.24% of the sample) with values of above 1 have been set to 1. From World Bank (2009).

GDP per Capita: In 1000 US\$, at constant US\$ (year 2000). From World Bank (2009).

Mass Killings: Dummy variable taking a value of 1 when mass killings are reported. From Political Instability Task Force (2010). In the Online Appendix, we also make use of the mass killings intensity information contained in this dataset, that distinguishes 11 different intensity levels ranging in steps of 0.5 from 0 to 5.

Mountainous Terrain: Percentage of territory covered by mountains. From Collier, Hoeffler and Rohner (2009).

Oil Production(/GDP): Total value of current oil production (/ GDP). Production quantities and prices from British Petroleum (2009), GDP in current prices from World Bank (2009).

Population: In 10 million people. From World Bank (2009).

Population Density: From World Bank (2009).

Total resource depletion: Total rents from energy+mineral+forest depletion in percent of Gross National Income at market prices. Rent = (Production Volume) x (International Market Price - Average Unit Production Cost). From World Bank (2010).

Trade over GDP: Total value of trade divided by total GDP. From World Bank (2009).

Variables on the ethnic group level

Group co-ethnics abroad: Number of countries in which the same ethnic group also exists. Computed with GIS based on the group boundaries from the "Geo-referencing of ethnic groups" (GREG) dataset (Weidmann, Rod and Cederman, 2010).

Group geographic concentration: Corresponds to the ratio of the area where a given ethnic group in a given country is the largest group divided by the total area where the group is present in this same country. Computed with GIS based on the group boundaries from the "Geo-referencing of ethnic groups" (GREG) dataset (Weidmann, Rod and Cederman, 2010).

Group involved in civil conflict: Variable "Incidence" from Cederman, Buhaug and Rod (2009).

Group's diamond production dummy: Constructed with GIS based on the group boundaries from the "Geo-referencing of ethnic groups" (GREG) dataset (Weidmann, Rod and Cederman, 2010) and the geo-referenced DIADATA dataset on the location of diamonds (from Gilmore et al., 2005).

Group's distance to capital: In 1000 kilometers. From Cederman, Buhaug and Rod (2009).

Group's population / Country population: Group population from Cederman, Buhaug and Rod (2009), country population from World Bank (2009).

Group's satellite light intensity: Average light intensity during night in the ethnic group's territory, measured with the help of meteorologic satellites. Rescaled, such that values range from 0-6.3. This data is from the National Oceanic and Atmospheric Administration (2010). Data on Average Visible, Stable Lights, & Cloud Free Coverages. In particular, we use their "cleaned" and "filtered" version of the data, which "contains the lights from cities, towns, and other sites with persistent lighting, including gas flares. Ephemeral events, such as fires have been discarded. Then the background noise was identified and replaced with values of zero."

Group's share of mountainous terrain: From Cederman, Buhaug and Rod (2009).

Group's soil quality: Part of the group's territory with high-quality fertile soil. Constructed based on the Harmonized World Soil Database (Fischer et al., 2008). Their complete global grid of nutrient availability is ranked from 1 ("no or slight constraints") to 4 ("very severe constraints"), and also including categories 5 ("mainly non-soil"), 6 ("permafrost area") and 7 ("water bodies"). Our dummy takes a value of 1 for categories 1 and 2, categories 3 to 6 get value 0, and category 7 is set to missing.

Mass Killings: Military massacres of suspected rebel supporters (on the group level). From Minorities at Risk (2009), variable Rep22. In columns 1, 3, 4, 5, and 7 of Table 4 coded as dummy, taking a value of 1 when Rep22 equals 1 or more. Coded as 0 in the columns 1-4 of Table 4 for all groups that are not classified as Minorities at Risk.

Percentage of group territory covered with oil and gas: Constructed with GIS based on the group boundaries from the "Geo-referencing of ethnic groups" (GREG) dataset (Weidmann, Rod and Cederman, 2010) and the location of oil and gas fields from the geo-referenced petroleum dataset (PETRODATA) from Lujala, Rod and Thieme (2007).