Subsidizing Rebels, Taxing Atrocities

Saving Lives in Civil Wars

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Abstract

The Syrian civil war has lasted over five years and has resulted in the deaths of over 400,000 civilians. The relatively restrained policy of the US toward Syria has sometimes been criticized as inadequate. Would a limited intervention motivated by humanitarian concerns have reduced the death toll at an acceptable cost? Limited intervention would affect the conflict primarily by strengthening the rebel side and raising the cost to the regime of attacking civilians. I show using a game theoretic model that fostering a balance of power between the government and the rebels would only lead the government to commit more atrocities and prolong the war. Raising the cost to the government of committing atrocities, however, could be beneficial under certain conditions. I then discuss four policy options considered during the Obama administration and assess their likely effects.

Keywords: Civil War, Game Theory, Intervention, Mass Killing, Responsibility to Protect, Syria

Introduction

Over 400,000 Syrians have lost their lives in the civil war that started in 2011, and millions more have been displaced from their homes.[1] In contrast to the case of Libya, the United States, under President Obama, took a relatively non-interventionist stance in Syria, intervening militarily only in a limited way against the Islamic State (IS) starting in 2014. Russia's subsequent intervention on the side of the Assad government went unchallenged, and it tipped the scales in favor of the incumbent regime. Obama's hands-off approach was widely criticized, within and outside the government, and many advocated a more forceful role for the US on humanitarian and other grounds.

Given the Assad regime's deliberate targeting of civilians, US inaction seemed to make a mockery of the UN's doctrine of "responsibility to protect," or R2P, according to which the international community is supposed to step in to protect civilians from mass killing when their governments fail to do so. In a remarkable development, over 50 US State Department officials submitted a "dissent memo" in the summer of 2016 criticizing the passive policy and urging a more interventionist stance.[2]

The Obama administration, however, confronted a fundamental constraint in making policy on Syria: the more forceful the intervention, the more costly it is. After 15 years of war in Afghanistan and Iraq, the US public was understandably leery of further commitments to conflicts in Middle Eastern nations. As a result, even the harshest critics of the Obama administration ruled out a large commitment of ground troops. The scope of potential intervention was therefore limited in how costly it could be in lives and money. An all out invasion to physically stop the killing was politically off the table.

The Trump administration has shown little interest in the Syrian conflict and even seems disposed to at least verbally support Russian intervention on the side of Assad. A future US humanitarian intervention in Syria would therefore seem even less likely than under Obama. The question remains, however, could the US under President Obama could have done anything, short of invasion, to limit the humanitarian catastrophe that unfolded in Syria? Could tens or even hundreds of thousands of lives have been saved at an acceptable cost?

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[1] This paper was written as part of a project on the Syrian civil war undertaken by the United States Holocaust Memorial Museum, led by Lawrence Woocher. Contact the author at Department of Political Science, University of Wisconsin, kydd@wisc.edu.

[2] Max Fisher, "The State Department's Dissent Memo on Syria: An Explanation," *New York Times*, June 22, 2016, accessed at http://www.nytimes.com/2016/06/23/world/middleeast/syria-assad-obama-diplomats-memo.html.

This is a special case of a more general question, can limited international military interventions save lives in civil wars? Short of outright conquest, there are two ways to lower the civilian death toll in a civil war. First, the international community may try to bring the war to an end. Wars end when one side defeats the other, or the two sides come to a negotiated settlement. Intervention could in theory help produce either outcome. In the case of Libya, the North Atlantic Treaty Organization (NATO) became the rebels' air-force and helped them defeat the incumbent regime. If the combatants are relatively evenly matched, or are weak compared with the intervening power, limited military intervention can tip the scales and lead to victory for one side, shortening the war.

In the case of Syria, however, with the example of Libya's post-conflict instability before them, the Obama administration was uncomfortable with the idea of helping the rebels destroy the Assad regime. Instead, the interventionists advocated aiding the rebels just enough to "bring Assad to the bargaining table" and so produce a negotiated settlement. The theory was that if the regime could be convinced that it would not win on the battlefield, it would become willing to negotiate, ending the war and giving hope for a more democratically governed Syria. Indeed, some scholars have argued that civil wars end through negotiations when the parties arrive at "hurting stalemates" in which they both realize they cannot win (Zartman 1989). Since the international community favored the rebel side anyway, it made sense to support them. In effect, the advocates of intervention argued that *subsidizing rebels* would shorten the war, as well as lead to a more desirable outcome.

But will subsidizing the weaker side actually shorten a civil war by leading to successful negotiations? There is reason for skepticism. Most civil wars end through victory and defeat, rather than negotiation, although the percentage ending in negotiation increased sharply in the 1990s, when the international community took more of an interest in fostering negotiations to end civil war (Licklider 1995, Toft 2010). Negotiated settlements are hard to achieve and subject to breakdown (Walter 2009). A key reason is that, unlike in the international arena, states can craft deals and retain some ability to defend themselves; whereas, in civil war contexts, the parties worry that compromise solutions will leave them vulnerable to exploitation in the future, and so are basically not much better than outright defeat (Walter 1997).

Since the parties devalue compromise solutions, they are effectively risk preferring and so the outcomes of civil wars tend to be lopsided victories for one side or the other, whether they are achieved on the battlefield, or at the negotiating table. As a result, fostering a balance of power between the rebels and the government is a recipe for a longer war, rather than a shorter one. It will encourage the rebels to be intransigent without actually producing significant concessions from the government side. In the civil war dataset compiled by Monica Toft, for instance, the average duration of civil wars that end through victory by either the government or rebels is approximately six years. Wars that end in negotiations, by contrast, have an average duration of 15 yearsover twice

as long.[3] Creating a balance of power, therefore, by subsidizing weak rebels, may prolong wars rather than shorten them.

If the war cannot be shortened, the international community could at least try to convince the parties to fight more cleanly by not targeting civilians. The primary tack of the international community here has been to try to punish actors who are responsible for atrocities. International justice proponents advocate punishing leaders for killing civilians. This is the path taken by the post-conflict tribunals such as the ad hoc courts set up after the breakup of Yugoslavia and the Rwandan genocide, and more generally under the International Criminal Court. Unfortunately, such tribunals can only punish leaders if they lose a war, or if they agree to a compromise solution that they undoubtedly expect will protect their liberty, only to be subsequently betrayed, apprehended, and extradited. This conditionality of the punishment may encourage leaders who have committed crimes to cling to power all the more and prolong conflicts (Snyder & Vinjamuri 2003/04). This problem raises the issue of whether they could be punished while still in office, and indeed while still fighting the war. Punishment could theoretically come in real time during the war through air strikes designed to punish specific atrocities. In effect, the international community would be attempting to impose a *tax on atrocities*, so that the government would fight a cleaner war. The State Department dissenters essentially advocated that approach when they recommended punishing the Assad regime for cease-fire violations. Proposals for "no-fly zones" also indirectly tax atrocities, in that they make it more costly for the government to commit them.

Taxing atrocities may also seem like a good idea, but it too has potential pitfalls. For one thing, that approach confronts the classic dilemma between the cost and probability of war. War is rare in part because it is costly. If you reduce the cost of war, you reduce the disincentive to engage in it. You therefore run the risk of making it more likely, or longer lasting (Wittman 1979). Specifically, if rebel groups know that the government side will not commit mass atrocities because the international community has made that too costly for them, that knowledge may encourage them to rebel, thereby generating a war that would not have occurred otherwise (Kuperman 2008*b*). The total death toll could therefore be much greater.

To analyze the dilemmas involved in subsidizing rebels and taxing atrocities in more detail, I present a formal model of civil war along with historical analyses of the critical junctures in which the US considered alternative policies in Syria. The model presents a theory of the effect of possible intervention strategies on the parties' decisions about whether to fight and if so how cleanly. The historical analysis helps identify (a) what options were on the table, (b) what decisionmakers

[3] Author's calculations based on the Toft dataset.

thought their advantages were, and (c) why they were ultimately rejected in favor of the hands-off policy ultimately pursued. In particular, I will consider four main options:[4]

1. Arm and train "moderate" rebel groups. This option was the core of the proposal developed by then-CIA Director David Petraeus and Secretary of State Hilary Clinton in the summer of 2012. It was supported by Defense Secretary Leon Panetta and Joint Chiefs of Staff Chair General Martin Dempsey, but was eventually rejected by President Obama.[5]

2. Bomb the government side. This option was the main recommendation of the anonymous State Department officials who submitted a "dissent channel" memo in the summer of 2016 criticizing President Obama's Syria policy for being too passive. It was also the main alternative considered during the crisis over the Assad regime's use of chemical weapons in 2013.

3. Impose a no-fly zone. This was one of the options mentioned as being under consideration by General Dempsey in a declassified July 2013 memo to Senator Carl Levin.

4. Establish safe havens. This was another of the options in the Dempsey memo.

The implications of the analysis can be summarized in two broad points. First, given that the US did not actually want the rebels to win outright, aiding them enough to produce a balance of power would have been a mistake. For one thing, aid to the rebels that is unconditional on the level of atrocities will actually encourage the government side to commit *more* atrocities, in order to counteract the aid to their adversaries. For another, because civil wars tend to end in victory and defeat rather than negotiation, creating a balance of power is likely to prolong a conflict rather than shorten it. Unconditional aid to the rebels therefore causes the government to commit more atrocities and prolongs the war, a lose-lose outcome as far as humanitarian goals are concerned. Second, limited strikes designed to impose a tax on atrocities by the government side are more likely to be beneficial. Their primary effect would be to get the government to commit fewer atrocities. It would also shift the balance of power toward the rebels to some degree, and so encourage them to continue fighting. This sets up a potential dilemma, intervention would result in a war with fewer atrocities, but one that might last longer. Whether the benefit outweighs the cost depends on the magnitude of each. The less effect atrocities have on the balance of power and the more callous the rebels are toward civilian deaths, the more likely intervention will be beneficial on net.

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[4] See also Derek Chollet, "Inside Obama's Syria Choices (A Guide for Dissenting Diplomats)," *Defense One*, June 20, 2016, http://www.defenseone.com/ideas/2016/06/defense-obamas-syria-choices/129230/.

[5] Michael R. Gordon and Mark Landler, "Senate Hearing Draws Out a Rift in US Syria Policy," *New York Times*, February 7, 2013.

In what follows, I first discuss the literature on humanitarian intervention and related topics. I then argue that the actors in civil warsthe rebels and the governmentare likely to be risk-acceptant rather than risk-neutral or risk-averse. Then, I present a model of civil war between risk-acceptant actors and show that balances of power make war more likely and elucidate the conditions under which punishing atrocities will be beneficial on net. Finally, I discuss policy options that were considered during the Syrian campaign.

Humanitarian Intervention and R2P

Mass killing, like war, is as old as human history. Humanitarian intervention to save lives is a more recent phenomenon. Various European states intervened or threatened to intervene in the Ottoman Empire in the 19th century to defend the safety of Christian minorities. But when the Ottomans began a campaign of deportation and killing against the Armenians in 1915 during World War I, intervention was not forthcoming, and an estimated 1.5 million Armenians lost their lives. Polish intellectual Raphael Lemkin coined the term genocide to describe the crime and agitated for an international treaty to ban it. The Holocaust followed and again no specific action was taken to prevent it, beyond the waging of all out war against Nazi Germany.

Lemkin's dream was fulfilled, however, when the United Nations passed a convention against genocide in 1948. Mass killing persisted in the post-World War II era, however, prominent cases include the Great Leap Forward in China from 1958 to 1961, the Khmer Rouge regime in Cambodia from 1975 to 1979, the Rwandan genocide in 1994, and war crimes in the Bosnian civil war in 1995. Only in the last case, with by far the smallest death toll, was international intervention forthcoming, in part due to the timing (after the end of the Cold War) and the location of the conflict (in Europe) (Power 2002).

The Bosnian conflict would be the turning point, however, at least for a time. When Kosovo began to show signs of incipient civil war in 1998, the US and NATO promptly sided with the Kosovo rebels, attempted to broker a deal on their behalf, and then bombed Serbia when Serbian leader Milosevic rejected the proposal. The bombing campaign eventually produced Serbian agreement to a modified version of the plan and paved the way for the eventual independence of Kosovo.

More broadly, at the United Nations, a campaign was under way to establish a principle of "responsibility to protect," by which the international community would have a duty to protect civilians if their government was targeting them for mass killing (Evans & Sahnoun 2002). In 2005, the UN World Summit duly endorsed the principles of R2P and momentum continued to build behind

the idea that the days when brutal leaders could kill their citizens with impunity were over. The Libyan civil war can be seen as a culmination of this evolution. When the Gaddafi regime advanced on the rebels in Bengazi, threatening to exterminate them, UN Security Council resolution 1973 authorized the use of force against the regime and NATO began a bombing campaign that ended only when Gaddafi was dead and his regime destroyed. To proponents, this intervention ended the debate; R2P had arrived (Evans 2011).

A number of critics, however, remained unconvinced. Some pointed out that all sides in civil wars commit some atrocities. For instance, in the Yugoslav wars, one of the largest ethnic cleansings was carried out by Croatia in 1995 against Serbs, and the Albanians also drove out the Serbs after they prevailed, with the help of NATO. Humanitarian intervention also kills some civilians, however careful the intervening powers. The money spent on humanitarian intervention could also be devoted to alternative uses, some of whichsuch as public health campaignswould save more lives (Valentino 2011). Others argued that the bar for intervention set by R2P was too permissive, and they set out more restrictive criteria for intervention (Pape 2012). At the diplomatic level, Russia and China felt that the Libyan intervention had gone too far, and that R2P was being used as a justification for pursuing regime change.

One of the most theoretically sophisticated and troubling critiques of humanitarian intervention is that posed by the ”moral hazard” literature. Many cases of mass killing take place during wars in which a rebel group representing the victims is fighting the government. The government uses mass killing in the course of prosecuting the war (Valentino, Huth & Balch-Lindsay 2004, Valentino 2014). Intervening to stop the government from engaging in mass killing is therefore to take sides in a civil war. Stopping mass killing lowers the cost of rebellion and raises the chance that the rebels will win; both outcomes encourage the rebels to fight. If international intervention can be expected in the case of atrocities, and that intervention will swing the outcome in favor of the rebels, then rebels have every incentive to provoke atrocities in order to trigger intervention on their side.

Evidence shows that in both the Bosnian case and the Kosovo case, the relevant leaders would not have decided to seek independence through war if they did not expect international intervention on their side. In the Bosnian case, this intervention was slow in coming and did not get them a better deal than the one they passed up to begin with. In the Kosovo case, intervention was immediate and forceful, and enabled them to achieve independence, which they could never have achieved on their own (Kuperman 2008*a*, Kuperman 2008*b*, Crawford & Kuperman 2006). A related literature in the context of alliances examines the dilemma between deterring an adversary from attacking an ally without encouraging that ally to provoke the adversary because of the security guarantee (Crawford 2003, Benson 2012).

A small formal theoretic literature exists on third-party intervention. Grigoryan presents a model in which the government can escalate to a high level of atrocities after intervention, but he does not consider interventions in which the third party tries to affect the cost of ongoing atrocities (Grigoryan 2010). An alternative approach is pursued by Esteban, Morelli, and Rohner (Esteban, Morelli & Rohner 2015, Esteban, Morelli & Rohner 2016). They consider the problem from a political economy standpoint and posit that winners of civil wars may sometimes implement genocide to lessen the future threat from rival groups, especially if their labor is not needed for economic growth.

I focus instead here on mass killing and atrocities conducted in the course of an ongoing war in order to achieve victory. Kydd and Straus examine a model in which the government and rebels bargain, if the bargaining fails, the government chooses a level of atrocities to commit, and then the third party chooses whether or not to intervene (Kydd & Straus 2013). The model presented here is closely related to the Kydd and Straus model in which the third party's intervention is considered to potentially affect the parameters of the game, but is not directly modeled as a choice.

An important related literature examines the relationship between the likelihood of war and the balance of power. In international relations, there is a long-standing debate on whether balances of power or imbalances of power produce peace (Organski & Kugler 1980, Siverson & Tennefoss 1984). Proponents of the balance of power argue that balances prevent anyone from thinking they can win a war easily and so deter conflict. Advocates of imbalances argue that a clear hierarchy of power leads to shared expectations about the outcome of war, and therefore peaceful resolution of disputes. Fearon points out that if the two sides in a typical take-it-or-leave-it bargaining model have risk-neutral preferences, then the balance of power should have no effect on the likelihood of war, a so-called neutrality result (Fearon 1993). Powell developed a model in which the crucial factor was the relationship between the balance of power and the distribution of whatever is being bargained over. The likelihood of war is minimized when the distribution of goods is aligned with the balance of power and is maximized when the distribution of goods diverges from the distribution of power (Powell 1996). Finally, Benson, Meirowitz, and Ramsay present a more general analysis that shows that if the bargaining parties risk-averse, then balances of power minimize the chance of war, while imbalances maximize it. (Benson & Ramsay 2016). Although risk aversion may accurately characterize most states in the international system, I argue below that the parties to civil wars are more likely to be risk preferring.

Why Civil War Participants Are Risk Preferring

An important characteristic of the participants in any conflict is their attitude toward risk, or their preferences over the possible resolutions of their dispute. The common assumption is that actors are risk-neutral, or have linear preferences over the issues in dispute. This assumption is mathematically tractable and supports the inference that the distribution of power and the likelihood of war are unrelated. However, there are strong reasons to believe that the participants in civil wars are risk-acceptant, or they undervalue compromise solutions. As we will see, that view will imply that balances of power are more war-prone than imbalances.

First consider the rebel side. Rebel leaders and their early followers are unusual people. They could be content to keep their heads down and make do with a bad situation, realizing that the government is much more powerful presently than any organization they could set up to fight it. But they choose not to. Instead, they form an organization to fight the state, which will result in certain hardship and will most likely end in failure and death, with only a small chance that they will eventually win, defeat the state, and reap the rewards. If a spectrum of risk attitudes exists in society, from extremely risk-averse to extremely risk-acceptant, the individuals at the risk-acceptant end of that spectrum will be attracted to the idea of leading such a rebellion. Thus risk-acceptant individuals will self-select into leadership roles in rebellions, and risk-neutral and risk-averse types will opt out, until the rebellion looks much more likely to succeed than it does in the early days. Thus, by self-selection, rebel leaders tend to be risk-acceptant and devalue compromise solutions (Colgan 2013).

What about incumbent rulers? In authoritarian regimes, they may themselves be former rebels or coup leaders, which may mean that they tend to be risk-acceptant as well. Even authoritarian leaders who inherited or otherwise got where they are more peacefully, however, have good reason to devalue compromise solutions and hence be risk-acceptant. Civil wars usually take place in authoritarian states. The incumbents usually have a strong organizational and military position by virtue of controlling the state. However, they also tend to lack popular support, ruling on behalf of a minority and oppressing the majority, or at least going against their preferences. If they enjoyed popular support, after all, they could be a democracy and would be less susceptible to civil war.

They face rebels who are organizationally, financially, and militarily weak to start with, but, at least in some cases, who can make successful appeals to large social groups, perhaps even a majority of the country, for support. The longer the rebel group is allowed to exist, the more powerful it will become. If the incumbents were to make a compromise peace with the rebels on terms that leave them free to organize politically, their increase in power will be even more rapid. Eventually, the

rebels will be in a position to attain power through democratic means or to renew their rebellion from a much stronger base.

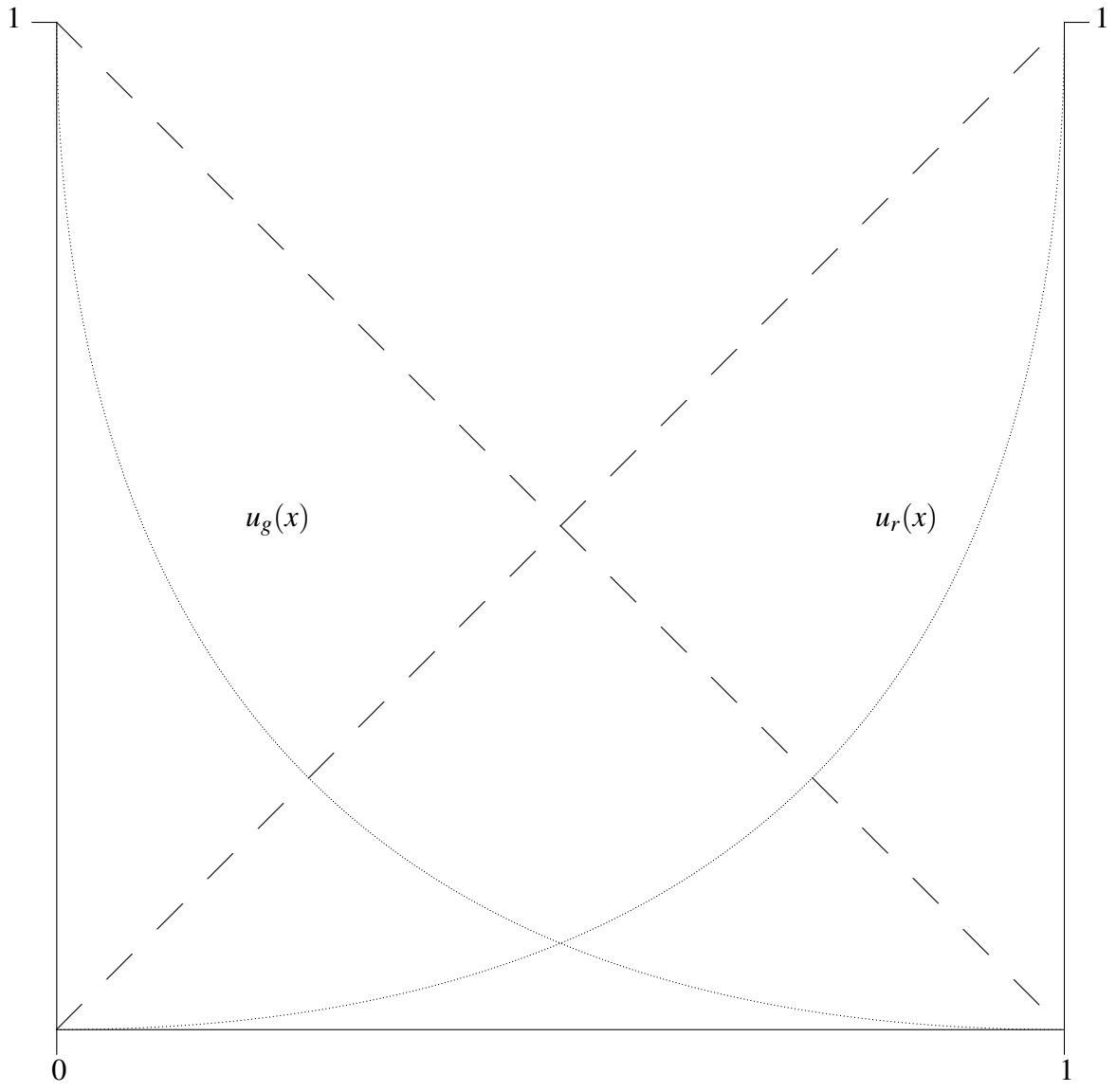
From the perspective of the incumbents, then, compromise solutions that do not involve crushing the rebels are often just decent intervals on the way to defeat. This situation was apparent in Zimbabwe, for instance, in that the incumbent white dominated Rhodesian regime agreed to majority rule with legal protections on property, but when Robert Mugabe was elected president, he consolidated power and eventually expropriated white farmers. The same phenomenon can be seen in Serbia after the Kosovo conflict. Although on the surface a negotiated settlement, the agreement to end the 1999 Kosovo conflict paved the way for independence for Kosovo and the eventual arrest and extradition of the Serbian leader Milosevic, who died in prison.

In Syria, the Assad regime represents the Alawite group which comprises only about 12 percent of the Syrian population. If the Alawites were to allow the Sunni community, with over 70 percent of the population, to mobilize freely, the Sunnis would eventually have the power to disenfranchise, oppress, or even wipe out the Alawites and other minorities. No arrangement of "power-sharing" much less democracy could offer any guarantee against such an eventuality, given Syria's complete lack of institutional constraints on politics. Because of this complex of factors, for incumbents in civil wars, compromise solutions are often not much better than losing outright, which implies that incumbents should devalue compromise solutions and have risk-acceptant preferences.[6]

I illustrate risk preferring utility functions in figure 1. The issue the government and rebels are negotiating over is represented by the variable $x \in [0,1]$. I assume that x is the size of the concession, so that the government likes lower values of x and the rebels like higher values. For instance, x could be the level of autonomy enjoyed by the ethnic group represented by the rebels. The government and rebels each have a utility function over x, denoted $u_g(x)$ and $u_r(x)$. I normalize the functions so that $u_g(1) = u_r(0) = 0$ and $u_g(0) = u_r(1) = 1$. Risk-neutral utility functions would be straight lines between (0,0) and (1,1) for the rebels, and (0,1) and (1,0) for the government side, illustrated as dotted lines. The utility functions illustrated are risk preferring, so they undervalue compromise solutions in the middle of the interval, in comparison to the risk-neutral case. As a result, as the government's concession grows bigger starting from zero, the government loses a lot of utility but the rebels gain hardly any. This makes the bargaining between them difficult.

[6] Note this is the opposite of Fearon's argument that governments are relatively strengthened by peace and so it is the incumbents who cannot commit not to take advantage of their newfound power (Fearon 2004).

Figure 1: Risk Preferring Utility Functions



A Model of Civil War

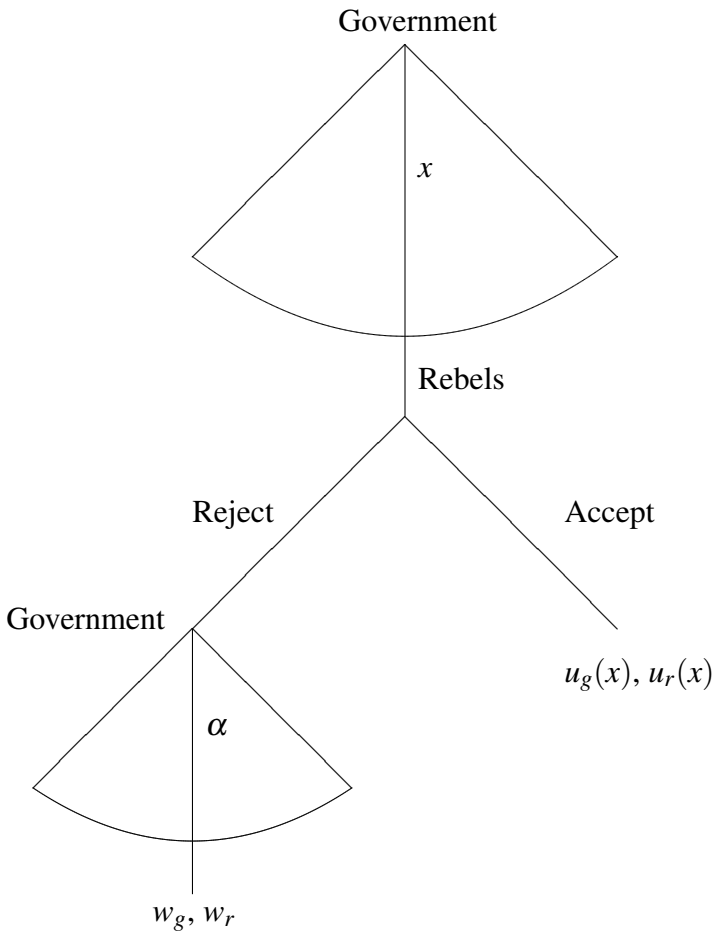
There are two players, the government, G, and the rebels, R. The two sides play the game illustrated in figure 2. I assume that before the game begins, some crisis occurs in regime stability, such that the apparent power of the government is weakened. The Arab Spring is an example, in that protest movements spread rapidly across the region, calling into question the ability of the regimes to maintain order. The government side decides how much to concede to the demands of the potential rebels in an effort to buy them off. If the government offers x and the rebels accept it, the game ends with payoffs $u_g(x), u_r(x)$. If the rebels reject the government's offer, a war breaks out.

The government then decides how to fight the war. In particular, it chooses the level of atrocities to commit, denoted $\alpha \in [0,1]$. If it sets $\alpha = 0$, the government scrupulously targets only rebel fighters. If it sets $\alpha = 1$, the government wages a large-scale genocidal campaign against all civilians associated with the rebels. The government can choose any intermediate level of atrocities it prefers. The war payoffs are denoted w_g for the government and w_r for the rebels. War is conceived of as a costly lottery between victory and defeat. The winner gets to impose its ideal point, worth 1 to it and 0 to the other side. The government has a p_g chance of winning, and the rebels' chance is $p_r = 1 - p_g$. War is also costly. Each side pays a cost of fighting, c_i, apart from whatever level of atrocities are committed.

I do not model the third party intervenor's decision directly, but consider three ways in which it could affect the game. First, it could offer unconditional help to the rebels, denoted h_r to improve their military capabilities and chance of winning the war. Such aid would be unconnected to the level of atrocities and would be designed to shorten the war by bringing the government side to the table.

Second, the third party could intervene to punish atrocities with limited attacks. These attacks could target government military equipment, as the 2017 US military strike against Syria's airbase did. If we denote the damage inflicted by the intervenor on government military assets per unit of atrocities δ, then the total damage to government forces will be $\delta\alpha$. The total advantage to the government side of committing atrocities will therefore be $(1-\delta)\alpha$. Third, the strikes could target economic assets of regime members and supporters, as did some of the air strikes against Serbia in the Kosovo war (Daalder & O'Hanlon 2000, 118). This could be thought of as imposing a tax on atrocities without affecting the military balance. If we denote this tax τ, then the additional cost of atrocities for the government side would be $\tau\alpha$.

Figure 2: The Civil War Game



With these parameters in hand, we can specify the probability of winning for the two players as well their costs for fighting. I assume that each side has military assets to bring to bear, denoted m_g and m_r. In addition, the chance of winning is a function of three factors: the level of atrocities the government commits, α, the level of unconditional help the rebels get, h_r, and the level of damage inflicted on government forces as a punishment for atrocities, δ. The probability that the government side wins combines these variables in the usual ratio contest success function (Skaperdas 1996), as follows:

$$p_g = \frac{m_g + (1-\delta)\alpha}{m_g + (1-\delta)\alpha + m_r + h_r} \quad (1)$$

$$p_r = \frac{m_r + h_r}{m_g + (1-\delta)\alpha + m_r + h_r} \quad (2)$$

The government's chances of winning increase with its base level of power, m_g, and with the level of atrocities it commits, α (provided that $\delta < 1$). The rebel side's chances of winning increase with its base level of power, m_r, with the unconditional help it is given, h_r, and with the conditional damage done by the intervenor as punishment for atrocities, δ.

Finally, I assume that atrocities are costly for both the rebels and the government. The rebels may feel them to be more costly than the government side, since their potential supporters are the ones being targeted, of course. Each side has a parameter, k_g and k_r that represents the marginal cost of atrocities to them. In addition, the government side may be punished for committing atrocities by an additional amount τ. The war payoffs for each side are therefore the following:

$$w_g = p_g - c_g - (k_g + \tau)\alpha \quad (3)$$

$$w_r = p_r - c_r - k_r\alpha \quad (4)$$

Equilibrium in the Model

We can solve for the equilibrium level of atrocities, denoted α^*, by maximizing the government's war payoff with respect to α as shown in the appendix. The war payoffs when the government chooses its equilibrium level of atrocities are denoted w_g^* and w_r^*.

To introduce some uncertainty into the model and generate a chance of war, I assume that the rebels' non-atrocity-related cost of war is distributed uniformly over the unit interval, $c_r \sim [0,1]$. For any given offer x, some rebels will accept and some will fight. The rebel who is indifferent

between accepting and rejecting the offer can be found by equating the payoff for accepting with that for fighting, $u_r(x) = p_r - c_r - k_r\alpha^*$, and solving for c_r.

$$c_r = p_r - k_r\alpha^* - u_r(x) \tag{5}$$

The probability of war, denoted L_w, is the likelihood that the rebels' cost is lower than this cutoff point. With the uniform distribution, this is just equal to the cutoff point.

$$L_w = p_r - k_r\alpha^* - u_r(x) \tag{6}$$

The likelihood of peace (an accepted offer) is just one minus the likelihood of war.

The government's utility for an offer x is the chance it is accepted times the value of the offer, plus the chance that it is rejected times the payoff of war. I denote this the government's objective function, $O_g(x)$.

$$O_g(x) = (1 - L_w)u_g(x) + L_w w_g^*$$

The optimal offer, x^*, maximizes this objective function.

$$x^* = \underset{x}{\operatorname{argmax}}\, O_g(x) \tag{7}$$

Implications of the Model

Humanitarian intervention can save lives by getting the government to commit fewer atrocities and bringing the war to an end. We are therefore interested in what the model says about the equilibrium level of atrocities and the probability of war.

The equilibrium level of atrocities (derived in the appendix) is the following:

$$\alpha^* = \sqrt{\frac{m_r + h_r}{(1-\delta)(k_g + \tau)}} - \frac{m_g + m_h + h_r}{1 - \delta} \tag{8}$$

The probability of war is the likelihood that the rebels reject the equilibrium government offer, x^*.

$$L_w^* = p_r - k_r\alpha^* - u_r(x^*) \tag{9}$$

Ideally, one would like to have a policy lever that both reduced the equilibrium level of atrocities and the probability of war. Worst of all would be one that increased both. Often, however, there will be a tradeoff between the two: lowering the level of atrocities may increase the likelihood of war, for example. More careful analysis is then required to weigh the pros and cons of the policy.[7]

We are especially interested in the effect on these variables of three factors: unconditional aid to the rebels, h_r, conditional damage done to government forces in retaliation for atrocities, δ, and non-military costs imposed on the government to punish atrocities, τ. I consider each in turn.

First, consider the effect of increasing unconditional aid, h_r on the government's equilibrium level of atrocities, α^*. As shown in the appendix, this effect is positive for weak rebels. That is, if the rebels are weaker than the government side, if the following inequality holds:

$$m_r + h_r < m_g + (1-\delta)\alpha^* \tag{10}$$

then aid to the rebels that increases their chance of winning will cause the government side to commit more atrocities, in an effort to at least partly redress their declining chance of winning. Put another way, when the government side is ahead, the marginal utility of atrocities will increase as the rebels start to catch up. Therefore, unconditional aid to the rebels has a positive effect on atrocities, and the government will commit more in equilibrium.

What about the effect of h_r on the probability of war? The derivative of the probability of war with respect to aid to the rebels is the following:

$$\frac{\partial L_w^*}{\partial h_r} = \frac{\partial w_r}{\partial h_r} - \frac{du_r}{dx}\frac{\partial x^*}{\partial h_r} \tag{11}$$

Aid to the rebels has conflicting effects. First, it strengthens the rebels, and so makes war more attractive to them. Second, it raises the equilibrium level of atrocities, which weakens the rebels and imposes additional costs on both government and rebels. In equilibrium, for plausible assumptions about the magnitude of these effects, the rebels will be somewhat stronger and both government and rebels will pay greater costs in terms of atrocities. On balance, aid will likely improve the rebels' war payoff, increasing the chance of war (the first term above). Counteracting this, if the rebels' overall payoff from war increases, the government will offer them a better deal, leading to more

[7] The *expected level of atrocities* is the product of the equilibrium level of atrocities and the likelihood of war, in this case $E(\alpha) = L_w^*\alpha^*$ (Kydd & Straus 2013, Kydd 2017). This is a good theoretical yardstick, in that if the expected level of atrocities declines, the policy is beneficial on net. However, the expressions for the effect of the policies on the expected level of atrocities are often cumbersome, and one can analyze the tradeoffs more simply using the expressions for the components above.

types of rebels accepting it (the second term). So there is a tradeoff: the rebels have an additional incentive to fight because their payoff for war increases; however, they also have an additional incentive to take the government's offer because it is better than before. When the players are risk-neutral (and do not care about atrocities) these effects cancel out and the probability of war is unchanged after the shift in relative power.

Unfortunately, when the parties are risk-preferring, as I argue civil war combatants typically are, the improvement in the offer is likely to be small in comparison to the increased incentive to fight. The reason is that if the government is stronger than the rebels, the offer is likely to be pretty meager from the rebels' perspective. This puts the rebels on the flat part of their risk-preferring utility function, near zero in figure 1. Slight improvements in the offer, therefore, provide little increase in utility to the rebels. However, the government is on the steep portion of their utility function. Even small additional concessions are extremely prejudicial to their interests. Therefore, they are unwilling to make big improvements in the offer. For this reason, with risk-acceptant actors, the chance of war is likely to go up with improvements in the strength of weak rebels.

Summing up the effect of aid to the rebels on the equilibrium level of atrocities and the likelihood of war, I find that subsidizing the rebels increases the equilibrium level of atrocities and makes war more likely. This is bad on both counts, and helps account for why the aid provided to the Syrian rebels by the United States, Turkey, and the Gulf States only encouraged regime atrocities and did nothing to end the war.

Result 1 *Attempting to create a balance of power by aiding weak rebels (increasing h_r), but not enough to help them win outright, will*

1. *increase the equilibrium level of atrocities, α^*, and*
2. *increase the likelihood of war, L_w^*.*

As an aside, the fact that war is more likely with balanced power sets up a potential dilemma for external powers considering intervention. If two external powers would both prefer that the conflict end, but have conflicting preferences on which side they prefer to win, they face a strategic situation (depicted in table 1). Let us assume that each intervenor gets v_i if its preferred side wins, loses v_i if its preferred side loses, suffers humanitarian costs k_i if there is a war, and pays intervention costs i_i from intervening. Further assume that power is balanced if neither or both sides intervene, leading to war, but is imbalanced if only one side intervenes, leading to peace.

Table 1: The Intervention Dilemma

		Player 2	
		Not Intervene	Intervene
Player 1	Not Intervene	$-k_1, -k_2$	$-v_1, v_2 - i_2$
	Intervene	$v_1 - i_1, -v_2$	$-k_1 - i_1, -k_2 - i_2$

With these assumptions, it is clear that mutual restraint is preferred to mutual intervention, since the result is the same, continued war, but intervention is costly for the third parties. However, each side may face incentives to intervene nonetheless. If player 2 is expected to stay out, player 1 will prefer to intervene and help its side win if $v_1 - i_1 > -k_1$. The more player 1 cares about helping its preferred side, v_1, the more likely this is to hold.

A similar condition holds for player 2. If player 2 is expected to intervene, player 1 could stay out, leading its preferred side to lose but ending the war, or intervene to prolong the conflict. Player 1 will want to intervene if $-k_1 - i_1 > -v_1$. Again, the more the players care about their side, the more the will want to intervene. Any of the four outcomes can be an equilibrium. If neither side cares much about its side, mutual non-intervention can be an equilibrium, especially if the cost of intervention is high. If both sides care a lot about its side winning, then mutual intervention and a prolonged war is the result. If one side cares about their side winning and the other does not, a one-sided intervention is likely that will bring the war to a conclusion on the favored side's terms. That seems to be the case in Syria, in that Russia cares more about securing a victory for Assad than the US cares about helping the rebels win.[8]

Let us now turn to limited strikes designed to put a tax on atrocities, and let's start with strikes on military assets of the regime, δ. As shown in the appendix, increasing δ decreases α^*, and so reduces the level of atrocities, if the following inequality holds.

$$(1-\delta)\alpha^* < m_g + m_r + m_h \tag{12}$$

That is, if the power generated by committing atrocities is less than the combined base power of the two sides plus the help given to the rebels, then destroying military hardware in response to atrocities will lower the government's level of atrocities. If atrocities generate so much military power as to overshadow all the other power resources available to the parties, then destroying the government's hardware will cause it to compensate instead by increasing its atrocities. The more military resources that are being destroyed in retaliation for atrocities, the higher δ, the more

[8] For more on mutual intervention, see Toukan (2016).

easily this condition is met, so the more likely the government is to scale back in the face of further punishment. If δ is increased to 1, the government will stop committing atrocities altogether because their advantages have been nullified by the international destruction of other military assets.

How does destroying government military assets in retaliation for atrocities affect the probability of war? The derivative is as follows:

$$\frac{\partial L_w^*}{\partial \delta} = \frac{\partial w_r}{\partial \delta} - \frac{du_r}{dx}\frac{\partial x^*}{\partial \delta} \tag{13}$$

The analysis is similar to the previous case with one important exception. With unconditional aid, the entire point of the aid is to shift the balance of power in favor of the rebels. This is what really improves the rebels' war payoff dramatically. Here, increasing δ is only meant to lessen the military advantage of atrocities, not to turn the tables on the government side altogether. Hence the effect on the rebels' war payoff, w_r, should be much smaller than in the previous case, when the goal is to get the rebels to parity. Thus if atrocities are not the "war winning weapon" in the conflict, so the government would be willing to scale them back and this would not radically alter the balance of power, then increasing δ would have the effect of scaling back the level of atrocities without substantially increasing the likelihood of war. For instance, in the case of Syria, the regime was apparently very cautious at first, strictly limiting the number of civilians that could be killed per day. Only when no response was forthcoming from the international community did the regime gradually lift these restraints. Another important factor is how much the rebels care about civilian lives. If the rebels are *callous*, that is, have a low k_r, or do not care that much about civilian atrocities, they will not be deterred by them, nor encouraged by their absence. As a result, lowering α^* will have less effect on the probability of war. In that case, lowering the level of atrocities should be beneficial on net.

Finally, consider τ, the non-military tax on atrocities. First, by inspection of Equation 8, increasing τ decreases α^*. That is, raising the tax on atrocities causes the government to commit fewer of them. So just as in the case of military punishment for atrocities, non-military punishment should cause the government to lower the level of atrocities.

What about the probability of war? The comparative static is the following:

$$\frac{\partial L_w^*}{\partial \tau} = \frac{\partial w_r}{\partial \tau} - \frac{du_r}{dx}\frac{\partial x^*}{\partial \tau} \tag{14}$$

The analysis is similar to that for δ. Causing the government side to commit fewer atrocities than it otherwise would will shift the balance of power somewhat to the rebels. But again, this is not the

goal, but rather a byproduct. The resulting shift could therefore be much smaller than in the first case where the outside power is increasing unconditional aid, h_r.

I sum up the analysis for δ and τ in the following result:

Result 2 *Imposing a military (δ) or non-military (τ) tax on atrocities will*

1. *Lower the government's level of atrocities, (α^*), (provided, in the case of δ, that atrocities generate less military power than the other sources of military power available to the government and rebels),*
2. *Raise the likelihood of war to some extent, and*
3. *On balance the policy will be beneficial to the extent that atrocities have a limited effect on the balance of power and the rebels are callous, or not too moved by civilian casualties.*

What is the bottom line on intervening to save lives in civil wars? The analysis shows that intervening with the goal of improving the rebels' chances of winning, but not enough to ensure victory, is bad on two counts. It encourages the government side to commit further atrocities, to counteract the aid. It also raises the chance of war, for weak and risk-acceptant rebels. The resulting war will therefore see more atrocities and last longer, a double loss from a humanitarian point of view. Intervening to tax atrocities, however, with either strikes on military targets or strikes on economic assets tied to the regime, should lower the level of atrocities, and only secondarily, and probably to a lesser extent, raise the chance of war. Such strikes therefore have the potential to save lives on balance, particularly if the regime does not consider atrocities vital to win and if the rebels are relatively unmoved by them.

The Policy Debate over Syria

Now, I turn to an analysis of some of the specific policy options that were considered for dealing with the Syrian civil war. Inspired by events in Tunisia, demonstrations in Syria began in March 2011. Initially pressing for democratic reforms and freedom, demonstrators soon began calling for Assad's ouster from power. The regime suppressed the demonstrations with increasing amounts of force, and casualties began to mount. By July, an armed insurgency broke out, fueled by popular discontent and defectors from the Syrian Armed Forces. The Free Syrian Army was formed, and

a Syrian National Council attempted to unite the rebels, but they remained divided and diverse in their ideology and goals. In August, President Obama called for democracy in Syria and for Assad to step down. In the fall of 2011 and spring of 2012, the civil war spread, and attacks on civilians using artillery and airpower became commonplace.

2012: Arm and Train the Rebels

To this point, US policy remained relatively hands-off, providing some non-lethal aid and assisting UN diplomatic efforts to broker a cease-fire. When the cease-fire collapsed in the summer, Secretary of State Clinton and CIA Director David Petraeus began consulting on a plan to engage the US more directly.[9] The core of the plan was a proposal to arm and train selected rebel forces. The plan ultimately gained support from Defense Secretary Leon Panetta and Chair of the Joint Chiefs of Staff, General Martin Dempsey.[10] Despite the support of the majority of his national security team, President Obama rejected the plan. His concern wasgiven the fractured nature of the Syrian oppositionthe possibility that US arms might eventually flow to radical groups affiliated with al-Qaeda and be used against the US. The plan's advocates intended to regroup and try again after the 2012 elections, but Petraeus was forced to resign after passing classified information to a journalist with whom he was having an affair, while Clinton suffered a concussion that temporarily sidelined her. Congressional advocates like Senator John McCain continued to press for some version of the plan.

With regard to the model, we can represent the effect of the arming and training the rebels by considering an increase in h_r, the parameter representing help to the rebels. Increasing h_r for weak rebels increases the chance of war. Given that the civil war was already underway, strengthening the rebels would have no impact on ending the conflict unless the aid was sufficient to enable the rebels to win, or at least convince the Assad regime to capitulate. As the model shows, however, this would require shifting the balance of power decisively in favor of the rebels, and as far as we know the arm-and-train proposal did not envision a level of aid sufficient to ensure victory. Thus the only possible effect of the arm-and-train program on the probability of war would be to stiffen the rebel groups resolve, in case they were considering giving up.

On balance then, arming and training the rebels would have made them stronger and the government weaker, which would have led to more government atrocities and a longer war. In retrospect, this

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[9] Michael R. Gordon and Mark Landler, "Backstage Glimpses of Clinton as Dogged Diplomat, Win or Lose," *The New York Times*, February 3, 2013.

[10] Julian Pecquet, "Pentagon Leaders Backed Plan to Arm Syrian Rebels," *The Hill*, February 7, 2013.

appears to be exactly what happened. Although the Clinton-Petraeus plan was rejected, the US subsequently launched a covert arms program for the rebels which a knowledgeable source has described as second only to the program of aid to the Afghan mujeheddin in the 1980s. The rebels may have even come close to defeating the Assad regime, prior to the Russian intervention. This of course would have ended one war, although given the Libya example and the rise of the Islamic State, it could hardly be expected to lead to peace in Syria

2013: The Chemical Weapons Showdown

In one of the key moments for US involvement, President Obama issued a threat intended to deter the Syrian government from using chemical weapons in August 2012, saying that the movement or use of chemical weapons would be a ”red line” that would ”change my calculus.”[11] The Assad regime crossed that red line a year later in August 2013 by using sarin, a nerve agent, against civilians in an attack that killed over a thousand people. That atrocity triggered a crisis in which the US came as close as it ever did to the use of force against the Syrian government.

In a speech to the nation, President Obama argued in favor of military action designed to ”deter” further use of chemical weapons and ”degrade” the regime's capabilities. [12] Although Obama claimed he had the authority to order the use of force on his own, he nonetheless decided to seek congressional approval, putting supporters of intervention, and critics of his former policy, in a position of having to attempt to rally support in a deeply skeptical Congress. The proposed Senate resolution would have authorized the use of force against the Syrian regime for 60 days, subject to renewal. However, in a remarkable diplomatic turnaround, an offhand remark by Secretary of State John Kerry that if the chemical weapons were gone there would be no need to use force was picked up by Russian Foreign Minister Sergey Lavrov and the US and Russia hammered out a deal by which Syrian chemical weapons were to be removed from the country and destroyed. This plan was then adopted, and President Obama withdrew his request for authorization for the use of force. [13]

The use of force proposed in response to the chemical weapons attacks amounts to a tit-for-tat punishment of atrocities, designed to deter their repetition. In the context of the model, it can

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[11] Mark Landler, ”Obama Threatens Force Against Syria,” *New York Times*, August 20, 2012.

[12] ”Statement by the President on Syria,” August 31, 2013, https://obamawhitehouse.archives.gov/the-press-office/2013/08/31/statement-president-syria.

[13] ”Remarks by the President in Address to the Nation on Syria,” September 10, 2013, https://obamawhitehouse.archives.gov/the-press-office/2013/09/10/remarks-president-address-nation-syria.

be considered an example of raising δ, to try to lessen the military advantage of atrocities for the regime (assuming that the targets would have been primarily military). If it were limited to atrocities committed with chemical weapons, the impact would likely have been negligible, since chemical weapons were rarely used and accounted for only a fraction of overall casualties, among both civilians and rebels. However, the principle could be extended to other forms of attacks on civilians, such as the bombing or shelling of densely populated areas. What would be the effect of such a policy? As the model indicates, imposing a tax on atrocities has a direct effect of lowering the equilibrium level of atrocities, α^*, which has the indirect effect of reducing the government's chance of winning, increasing the rebels' chance of winning, and lowering the rebels' cost of fighting, making war more attractive to the rebels. The direct effect of making the government fight more cleanly will dominate if the chance of winning does not depend too strongly on the level of atrocities and if the rebels do not care too much about civilian casualties. Although these are judgement calls, I would argue that in Syria in 2012, one could make a reasonable case that given that the rebels were willing to fight with high atrocity levels, reducing the level of government atrocities would save lives without unduly prolonging the war.

A key question is how much did the government's chance of winning depend on the level of atrocities. Given the sectarian differences between the regime and the opposition, and Assad's history of oppression, a hearts-and-minds counterinsurgency strategy can be considered a non-starter for the government. The regime's advantages lay in hardware and organization, not in intelligence or popular support. In such cases, indiscriminate targeting becomes highly likely, simply because the government finds it difficult to fight in any more discriminating way. Preventing all atrocities, therefore, would certainly lower the government's chance of winning and boost that of the rebels.

However, it is important to remember that the Syrian civil war was never a classical guerrilla war. The rebels never hid among civilians or attempted to blend into the population, or hide in some remote countryside. Such a strategy would be infeasible in a desert country like Syria. Instead, from the outset, opposition forces organized themselves in more or less conventional military units and attempted to seize territory and defend it from government forces. Government forces understandably substituted firepower for lives in their efforts to retake these areas. But it seems reasonable to expect that they could have been persuaded to use less firepower, and hence spare more civilian lives, in their offensives. Thus increasing the cost to the regime of committing atrocities could arguably have saved lives without unduly altering the balance of power.

2013: The Dempsey Memo

In July 2013, just before the chemical weapons crisis broke out, Senator Carl Levin, Chair of the Senate Armed Services Committee, requested an unclassified letter from the Chair of the Joint Chiefs of Staff, General Martin Dempsey, outlining military options for the Syrian conflict. Dempsey's letter provides a window into the options the military was prepared to undertake.

The first was to train the opposition without providing weapons, making this a watered-down version of the arm and train program advocated by Clinton and Petraeus, minus the weapons that might fall into the wrong hands. As I discussed above, this option would shift the balance of power in favor of the rebels, but not enough to help them win, and so would probably only prolong the war without reducing civilian casualties.

The second option was to conduct "limited, standoff strikes." The description of this option makes clear that a substantial air campaign against the Syrian regime was being considered, striking hundreds of targets in order to seriously weaken the regime. The "risk" was that the regime might be able to "withstand" the campaign by dispersing its assets. However, rebel victory is not mentioned as the goal of such a campaign. If that is taken at face value, the goal of the campaign would then appear, once again, to create a balance of power, in this case, not by aiding the rebels but by weakening the regime. The same analysis applies here, therefore, such an option would likely have prolonged the war without facilitating a negotiated solution. Importantly, since the air campaign would be unconditional on Assad's behavior, it would not raise the cost of atrocities for the regime, and so do nothing to reduce the ongoing civilian loss of life.

The third option was to establish a no-fly zone. The policy would be to ground all Syrian aircraft, preventing government forces from using their air assets for strikes on rebel positions. Note, this option was being envisioned before Russian intervention in 2015. Although a no-fly zone could have been imposed, Dempsey wrote that it would be unlikely to "shift the momentum" or "reduce the violence" because the government forces were primarily land based. With regard to the model, it could be considered to marginally shift the balance of power in favor of the rebels and increase the cost to the regime for committing atrocities, assuming that for some military missions air strikes were the best or cheapest option. Given the regime's lack of precision guided munitions, its air strikes were indiscriminate in nature. Making it impossible for the regime to strike indiscriminately deeply behind the front lines would have eliminated some of the more egregious atrocities of the war, including numerous air raids on hospitals and city centers. Of course, the government could have attempted to substitute tactics by committing more atrocities with its land forces, but some

missions might have been infeasible with land forces. The model therefore suggests some utility for the no-fly zone, as a means of making atrocities committed with air forces prohibitively costly.

The fourth option was to create ”buffer zones” or safe havens along the border with Turkey or Jordan. The US would defend these regions from attack, and they could be used as safe base areas for the rebels and as refugee camps. Civilians lucky enough to reach the safe havens would therefore be protected, so long as the US continued to defend them. Of course the regime could compensate by targeting civilians elsewhere, in an effort to reconsolidate power in other parts of the country before taking on the safe areas. Unless the safe areas were large, it is hard to envision how they would serve to protect many civilians, and civilians could also be targeted as they attempted to reach the safe areas.

Such a policy might have played a role in preventing the refugee outflow into Turkey and Europe, but it seems unlikely to have reduced atrocities in the combat zones. Its main effect would have been to afford a safe rear area for the rebels, shifting the balance of power somewhat in their favor. Again, the model suggests that this would only serve to prolong the war.

The final option was an assault on Syria’s chemical weapons. It was envisioned as a substantial air campaign, accompanied by a no-fly zone. As discussed above, if this campaign were restricted to the chemical weapons infrastructure, it would have a limited effect on the war, given that chemical weapons accounted for only a tiny fraction of all casualties. The option ultimately considered the following month, when the chemical weapons crisis materialized, was a much more limited set of strikes designed to deter the use of chemical weapons, rather than destroy them as a whole.

Dempsey’s memo provides a fascinating glimpse into the internal deliberations of the Obama administration. It is clear from its framing that ”shifting the momentum of the war,” that is, strengthening the rebels, was viewed as desirable, but no analysis has been done of why that would be the case. Indeed, the risk is clearly recognized: if the regime collapsed in the absence of a ”viable opposition,” the results could be catastrophic. The model suggests that creating a balance of power is a mistake, which makes training for the rebels, unconditional bombing campaigns against the government, and the provision of safe havens for the rebels questionable policy goals. Instead, attempts to raise the costs of atrocities by imposing a no-fly zone and retaliating conditionally to punish atrocities could have potentially reduced the death toll.

2013 - 5: The Rise of IS and the Russian Intervention

Starting in 2013, a new factor emerged in the Syrian civil war, the Islamic State (IS). The IS emerged from the ashes of the Sunni insurgency in Iraq and quickly gained strength in the anarchic conditions prevailing in Syria. It carved out a territorial base in northeastern Syria and then in 2014, it poured back across the border into Iraq conquering the northwestern portion of the country. The IS quickly distinguished itself from other rebel groups in Syria and from al-Qaeda by its extreme brutality, its ambition to build a state, its destruction of historic sites, its ability to attract foreign recruits and its ability to hit foreign countries with significant terror attacks, such as those in Paris in November 2015.

The US began air strikes against the IS in Iraq in the summer of 2014. US intervention helped stabilize the situation in northern Iraq, helping the Kurdish forces there to regain previously held territory. In September, the US extended the air campaign to Syria and so for the first time used military force in the Syrian civil warnot against the Assad regime, but against the IS. The US also began a modest program of non-lethal aid and training for selected military units of the Free Syrian Army.

The rise of the IS changed the strategic situation in Syria dramatically. Now, the possibility that the Assad regime might collapse became a real danger, since the IS could well be the strongest remaining group, and hence be in a position to take over the entire country. The US was placed in the impossible situation of wanting to strengthen the non-IS rebels, but not enough to help them defeat the government, and simultaneously wanted to defeat the IS. Given that the US still did not trust the ”moderate” Syrian rebels, it had two sides it wanted to defeat, Assad and the IS, but no one it really wanted to win.

Russia, as it turned out, had a much simpler strategic problem in that it simply wanted the Assad regime to reconsolidate power over the country, despite his record of atrocities. In September 2015, Russia intervened with air strikes on the government side, striking some IS targets, but focusing mainly on rebel groups facing government forces. Russian and Iranian support for Assad tipped the balance of power and has enabled the government to retake significant territory from the rebels, most notably the city of Aleppo. The US effectively failed to counter Russian intervention, and its influence in Syria waned even further.

2016: The Ceasefire and the Dissent Memo

UN efforts to broker a peace deal or at least a cease-fire were reinvigorated in December 2015 and a cease-fire negotiated by the US and Russia went into effect in March 2016. By the summer, it had unraveled and the Assad regime began several offensives against the rebels, with Russian support.

In a last bid for a more forceful policy, some 50 officials in the Department of State circulated a "dissent memo" criticizing the administration's weakness and urging tougher action.[14] They urged air strikes to punish the Assad regime's violations of the cessation of hostilities agreement and more broadly, to weaken the government's military position. The authors explicitly argue that if the government's attacks go unpunished, they will continue to fight on in hopes of ultimate victory, and, conversely, that weakening the government side will lead to negotiations and a settlement. They further argue that attacking the regime would help build support with the Sunni population of Syria and wanted help with the fight against the IS. They also claim that using force would aid the peace process by generating greater respect for US diplomatic initiatives, which, in the absence of a forceful US role, could be safely ignored or exploited.

In light of the model, some of the arguments of the dissent memo seem valid and others less so. On the one hand, attempting to extract concessions from Assad by creating a balance of power would probably be unsuccessful, for the reasons discussed. On the other hand, raids designed to punish atrocities and persuade the government to fight a cleaner war could conceivably have saved lives. Strikes designed to punish cease-fire violations might have been especially promising, given that even a stalemated or frozen conflict would be preferable to an ongoing civil war.

To sum up the Syrian case, the US faced a very tight set of constraints in considering military intervention. Large-scale invasion on the lines of Iraq or Afghanistan was off the table given Obama's preferences and domestic political constraints. Obama also seems to have decided, perhaps influenced by Libya, that an outright rebel victory was undesirable, so the option of intervening enough to tip the scales in the rebels' favor was also out. That left lesser level interventions designed to create a balance of power that would supposedly foster negotiations. Fear that US weapons might fall into the hands of radical groups prevented efforts to arm the rebels with more sophisticated weapons, particularly anti-aircraft capabilities, and fear of causing a regime collapse prevented large-scale attacks against the government side. The advent of the IS shifted the US focus away from the government-rebel conflict, to an effort to destroy the IS with the help of Kurdish fighters.

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[14] "State Department Draft Dissent Memo on Syria," *New York Times*, June 17, 2016, http://www.nytimes.com/interactive/2016/06/17/world/middleeast/document-state-dept-syria.html.

Russia took advantage of the lack of US involvement to pursue its much simpler strategic objective, victory for Assad.

Conclusion

Can international military intervention reduce the civilian death toll in civil wars, short of ground troop invasions sufficient to stop the killing by brute force? The answer is more complex than it might appear. I argue here that civil war participants tend to be risk-acceptant. Risk-acceptant actors tend to devalue compromise solutions. A model of civil war shows that in such circumstances, balances of power tend to promote war, whereas imbalances convince the weaker side to capitulate to the stronger. If the intervening party wants one side to win and is willing to tip the scales sufficiently to achieve that goal, then intervention could shorten the war and lessen the cost to civilians. Intervening half-heartedly to produce a stalemate on the theory that it will encourage negotiations is unlikely to succeed, however, since it will encourage intransigence by the formerly weaker side without producing concessions from the stronger side.

A better approach is to attempt to punish the side committing atrocities, usually the government side, in an attempt to lower the benefit and raise the cost of committing atrocities while the government is still fighting, rather than after the conflict is over, through international tribunals. If the government can be made to pay a higher cost for atrocities than its natural humanitarian instincts impose, that could convince them to reduce the level of killing. This too will shift the balance of power in favor of the rebels and lower their cost of fighting. But if these secondary effects are relatively weak, then on balance it will be beneficial to punish atrocities to encourage the parties to fight more cleanly. The Syrian civil war shows these dilemmas at work, as US policy makers groped for a strategy that would reduce the costs to civilians and ultimately failed to find one.

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Mathematical Appendix

Here, the results discussed in this paper are derived.

The Equilibrium Level of Atrocities

To find the equilibrium level of atrocities, we maximize the war payoff with respect to α. The first-order condition is solved for α as follows:

$$\begin{aligned}
\frac{\partial p_g}{\partial \alpha} &= k_g + \tau \\
\frac{(m_g + (1-\delta)\alpha + m_r + h_r)(1-\delta) - (m_g + (1-\delta)\alpha)(1-\delta)}{(m_g + (1-\delta)\alpha + m_r + h_r)^2} &= k_g + \tau \\
\frac{m_r + h_r}{(m_g + (1-\delta)\alpha + m_r + h_r)^2} &= \frac{k_g + \tau}{1-\delta} \\
(m_g + (1-\delta)\alpha + m_r + h_r)^2 &= \frac{1-\delta}{k_g + \tau}(m_r + h_r) \\
m_g + (1-\delta)\alpha + m_r + h_r &= \sqrt{\frac{1-\delta}{k_g + \tau}(m_r + h_r)}
\end{aligned}$$

Solving for the equilibrium level of α produces:

$$\alpha^* = \sqrt{\frac{m_r + h_r}{(1-\delta)(k_g + \tau)}} - \frac{m_g + m_h + h_r}{1-\delta} \tag{15}$$

The Impact of Unconditional Aid to the Rebels: h_r

First, let us consider the effect of increasing aid to the rebels on the equilibrium level of atrocities, α^*, the probability of war, L_w^*, and the expected level of atrocities, $L_w^* \alpha^*$.

The equilibrium level of atrocities, α^*

We take the derivative of α^* with respect to h_r as follows:

$$\begin{aligned}
\frac{\partial \alpha^*}{\partial h_r} &= \frac{1}{2}\left(\frac{m_r+h_r}{(1-\delta)(k_g+\tau)}\right)^{-\frac{1}{2}} \frac{1}{(1-\delta)(k_g+\tau)} - \frac{1}{1-\delta} \\
&= \frac{1}{2}\left(\frac{(1-\delta)(k_g+\tau)}{m_r+h_r}\right)^{\frac{1}{2}} \frac{1}{(1-\delta)(k_g+\tau)} - \frac{1}{1-\delta} \\
&= \frac{1}{2}\left(\frac{1}{(m_r+h_r)(1-\delta)(k_g+\tau)}\right)^{\frac{1}{2}} - \frac{1}{1-\delta} \\
&= \frac{1}{2\sqrt{(m_r+h_r)(1-\delta)(k_g+\tau)}} - \frac{1}{1-\delta}
\end{aligned}$$

It will be positive so long as the following holds:

$$\begin{aligned}
2\sqrt{(m_r+h_r)(1-\delta)(k_g+\tau)} &< 1-\delta \\
\sqrt{(m_r+h_r)(1-\delta)(k_g+\tau)} &< \frac{1}{2}(1-\delta) \\
(m_r+h_r)(1-\delta)(k_g+\tau) &< \frac{1}{4}(1-\delta)^2 \\
(m_r+h_r)(k_g+\tau) &< \frac{1}{4}(1-\delta) \\
m_r+h_r &< \frac{1-\delta}{4(k_g+\tau)}
\end{aligned}$$

This condition is equivalent to the rebels being weaker than the government side, as can be seen below. The government's strength is $m_g + (1-\delta)\alpha^*$, and the rebels' is $m_r + h_r$. The former beats

the latter when the following holds:

$$\begin{aligned}
m_g + (1-\delta)\alpha^* &> m_r + h_r \\
m_g + (1-\delta)\sqrt{\frac{m_r+h_r}{(1-\delta)(k_g+\tau)}} - (1-\delta)\frac{m_g+m_h+h_r}{1-\delta} &> m_r + h_r \\
\sqrt{\frac{(1-\delta)(m_r+h_r)}{(k_g+\tau)}} &> 2(m_r+h_r) \\
\frac{(1-\delta)(m_r+h_r)}{(k_g+\tau)} &> 4(m_r+h_r)^2 \\
\frac{1-\delta}{4(k_g+\tau)} &> m_r + h_r
\end{aligned}$$

So if the rebels are weaker than the government side, then strengthening the rebels leads to an increase in atrocities, as the government side tries to compensate. Increasing the tax on atrocities (τ and δ) lowers the threshold, over which the government will begin to scale back atrocities in response to increases in the rebels' strength.

The likelihood of war, L_w^*

Now consider the effect of aid to the rebels on the probability of war. The probability of war is the likelihood that the equilibrium offer is rejected.

$$L_w^* = p_r(h_r, \alpha^*) - k_r\alpha^* - u_r(x^*)$$

This depends on aid to the rebels through all three terms. The first derivative is:

$$\frac{\partial L_w^*}{\partial h_r} = \frac{\partial p_r}{\partial h_r} + \frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r} - k_r\frac{\partial \alpha^*}{\partial h_r} - \frac{du_r}{dx}\frac{\partial x^*}{\partial h_r} \tag{16}$$

The first term is positive, because the more powerful the rebels, the better war is for them. The second term is negative for weak rebels, because the government will commit more atrocities if the rebels get more aid, and the rebels' likelihood of winning declines with the level of atrocities. The third term is also negative, since the government will commit more atrocities in response to aid to the rebels, and the rebels feel that as a direct cost. The first three terms taken together are the

derivative of the rebels' war payoff with respect to their aid, $\frac{\partial w_r}{\partial h_r}$, so we can rewrite that as follows:

$$\frac{\partial L_w^*}{\partial h_r} = \frac{\partial w_r}{\partial h_r} - \frac{du_r}{dx}\frac{\partial x^*}{\partial h_r} \tag{17}$$

This brings us to the second term here (fourth term above). The first half is positivethe better the offer, x, the happier the rebels. However, if the rebels are weak and risk-acceptant, then this term will likely be small, because x^* will be low, so we are at the flat part of the rebels' utility curve. Thus even if the rebels get a better deal from the increase in help, it will have a small effect on their utility

The remaining question is what how aid to the rebels affects the equilibrium offer, x^*. Recall that the objective function is

$$O_g(x) = (1 - L_w)u_g(x) + L_w w_g^*$$

and the first order condition is

$$(1 - L_w^*)\frac{du_g(x)}{dx} - u_g(x)\frac{\partial L_w^*}{\partial x} + \frac{\partial L_w^*}{\partial x}w_g^* = 0$$

The derivative of the likelihood of war with respect to x is the negative of the derivative of the rebels' utility function,

$$\frac{\partial L_w}{\partial x} = -\frac{du_r}{dx}$$

so we can rewrite the first-order condition as follows:

$$(1 - L_w)\frac{du_g}{dx} + (u_g(x) - w_g)\frac{du_r}{dx} = 0$$

If we insert x^* into the first-order condition, it produces an identity.

$$(1 - L_w^*)\frac{du_g(x^*)}{dx} + (u_g(x^*) - w_g)\frac{du_r(x^*)}{dx} \equiv 0 \tag{18}$$

We can then take the derivative of the entire expression with respect to h_r:

$$\begin{aligned}
(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}\frac{\partial x^*}{\partial h_r} \\
-\frac{\partial L_w^*}{\partial h_r}\frac{du_g(x^*)}{dx} \\
+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}\frac{\partial x^*}{\partial h_r} \\
+\left(\frac{du_g}{dx}\frac{\partial x^*}{\partial h_r}-\frac{\partial w_g}{\partial h_r}\right)\frac{du_r(x^*)}{dx} &= 0
\end{aligned}$$

Expanding two of the terms:

$$\begin{aligned}
(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}\frac{\partial x^*}{\partial h_r} \\
-\left(\frac{\partial p_r}{\partial h_r}+\frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_r\frac{\partial \alpha^*}{\partial h_r}-\frac{du_r}{dx}\frac{\partial x^*}{\partial h_r}\right)\frac{du_g(x^*)}{dx} \\
+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}\frac{\partial x^*}{\partial h_r} \\
+\left(\frac{du_g}{dx}\frac{\partial x^*}{\partial h_r}-\left(\frac{\partial p_g}{\partial h_r}+\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_g\frac{\partial \alpha^*}{\partial h_r}\right)\right)\frac{du_r(x^*)}{dx} &= 0
\end{aligned}$$

We now isolate $\frac{\partial x^*}{\partial h_r}$

$$\begin{aligned}
\frac{\partial x^*}{\partial h_r}\left((1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}+\frac{du_r}{dx}\frac{du_g}{dx}+(u_g(x^*)-w_g)\frac{d^2u_r(x)}{dx^2}+\frac{du_g}{dx}\frac{du_r}{dx}\right) \\
=\left(\frac{\partial p_r}{\partial h_r}+\frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_r\frac{\partial \alpha^*}{\partial h_r}\right)\frac{du_g(x^*)}{dx}+\left(\frac{\partial p_g}{\partial h_r}+\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_g\frac{\partial \alpha^*}{\partial h_r}\right)\frac{du_r(x^*)}{dx}
\end{aligned}$$

and solve for it:

$$\frac{\partial x^*}{\partial h_r}=\frac{\left(\frac{\partial p_r}{\partial h_r}+\frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_r\frac{\partial \alpha^*}{\partial h_r}\right)\frac{du_g(x^*)}{dx}+\left(\frac{\partial p_g}{\partial h_r}+\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}-k_g\frac{\partial \alpha^*}{\partial h_r}\right)\frac{du_r(x^*)}{dx}}{(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}+2\frac{du_r(x^*)}{dx}\frac{du_g(x^*)}{dx}+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}} \tag{19}$$

The first term in parentheses is the derivative of the rebels' war payoff with respect to aid to the rebels, $\frac{\partial w_r}{\partial h_r}$, and the second term in parentheses is the corresponding term for the government, $\frac{\partial w_g}{\partial h_r}$. So we can rewrite as follows:

$$\frac{\partial x^*}{\partial h_r} = \frac{\frac{\partial w_r}{\partial h_r}\frac{du_g}{dx} + \frac{\partial w_g}{\partial h_r}\frac{du_r}{dx}}{(1-L_w^*)\frac{d^2u_g}{dx^2} + 2\frac{du_r}{dx}\frac{du_g}{dx} + (u_g(x^*) - w_g)\frac{d^2u_r}{dx^2}} \tag{20}$$

We now have an expression for how the equilibrium offer responds to subsidies for the rebels. We would expect it to be positive, that is, the government makes a greater concession the larger the subsidy to the rebels. The numerator is negative if we assume that the rebels' war payoff increases with their subsidy, and the government's war payoff decreases with the subsidy to the rebels. The denominator is negative if the second derivatives of the utility functions (at the equilibrium point) are small enough. In that case, the relationship is positive, as expected, and subsidizing the rebels convinces the government to offer them a better deal.

We can now finally express the derivative of the probability of war with respect to aid to the rebels, as follows:

$$\frac{\partial L_w^*}{\partial h_r} = \frac{\partial w_r}{\partial h_r} - \frac{du_r}{dx}\frac{\frac{\partial w_r}{\partial h_r}\frac{du_g}{dx} + \frac{\partial w_g}{\partial h_r}\frac{du_r}{dx}}{(1-L_w^*)\frac{d^2u_g}{dx^2} + 2\frac{du_r}{dx}\frac{du_g}{dx} + (u_g(x^*) - w_g)\frac{d^2u_r}{dx^2}} \tag{21}$$

Now, let us consider this quantity. We can easily show that if the parties are risk-neutral and do not care about atrocities, then this quantity is zero, so the likelihood of war is unrelated to aid to the rebels. With risk-neutrality, the two sides' preferences are linear, so that $u_r(x) = x$ and $u_g(x) = 1 - x$. In this case the denominator simplifies to -2, because the second derivatives of the utilities are zero and the first derivatives are $\frac{du_r}{dx} = 1$ and $\frac{du_g}{dx} = -1$. If the players do not care about atrocities, the war payoffs are unaffected by the level of atrocities. Since we know that $p_r = 1 - p_g$, the numerator can be simplified to $-2\left(\frac{\partial p_r}{\partial h_r} + \frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial h_r}\right)$, and since the -2s cancel out, the second term simplifies to -$\frac{\partial w_r}{\partial h_r}$ so the whole thing is zero. Therefore, with risk-neutrality, (and not caring about atrocities), aiding the rebels does not increase or decrease the probability of war, which is the standard neutrality result.

The Impact of Military Punishment for Atrocities, δ

. . . on α^*

The derivative of α^* with respect to δ is the following:

$$\frac{\partial \alpha^*}{\partial \delta} = \frac{1}{2}\left(\frac{m_r+h_r}{(1-\delta)(k_g+\tau)}\right)^{-\frac{1}{2}} \frac{(m_r+h_r)(k_g+\tau)}{(1-\delta)^2(k_g+\tau)^2} - \frac{m_g+m_r+h_r}{(1-\delta)^2} \tag{22}$$

This is negative when

$$\begin{aligned}
\frac{1}{2}\left(\frac{m_r+h_r}{(1-\delta)(k_g+\tau)}\right)^{-\frac{1}{2}} \frac{(m_r+h_r)(k_g+\tau)}{(1-\delta)^2(k_g+\tau)^2} &< \frac{m_g+m_r+h_r}{(1-\delta)^2} \\
\frac{1}{2}\left(\frac{m_r+h_r}{(1-\delta)(k_g+\tau)}\right)^{-\frac{1}{2}} \frac{(m_r+h_r)}{(k_g+\tau)} &< m_g+m_r+h_r \\
\frac{1}{2}\left(\frac{(1-\delta)(k_g+\tau)}{m_r+h_r}\right)^{\frac{1}{2}} \frac{(m_r+h_r)}{(k_g+\tau)} &< m_g+m_r+h_r \\
\frac{1}{2}\left(\frac{(1-\delta)(m_r+h_r)}{(k_g+\tau)}\right)^{\frac{1}{2}} &< m_g+m_r+h_r \\
\left(\frac{(1-\delta)(m_r+h_r)}{(k_g+\tau)}\right)^{\frac{1}{2}} &< 2(m_g+m_r+h_r)
\end{aligned}$$

We know from the derivation of α^* that

$$\sqrt{\frac{1-\delta}{k_g+\tau}(m_r+h_r)} = m_g+(1-\delta)\alpha+m_r+h_r$$

so substituting in we get

$$\begin{aligned}
m_g+(1-\delta)\alpha+m_r+h_r &< 2(m_g+m_r+h_r) \\
(1-\delta)\alpha^* &< m_g+m_r+m_h
\end{aligned}$$

Therefore, if the military power generated from atrocities is less than the combined base level of power of the two sides plus the rebels' international help, then destroying the government's military power in response to atrocities will result in fewer atrocities. If atrocities are so important that they generate more power than that, then the government will compensate for the destruction by committing even more atrocities. The larger δ is, the more likely increasing it will lower the level of atrocities. Of course, if $\delta = 1$, then the government will commit no atrocities.

. . . on L_w^*

The analysis is similar to that above. The comparative static is the following:

$$\frac{\partial L_w^*}{\partial \delta} = \frac{\partial w_r}{\partial \delta} - \frac{du_r}{dx} \frac{\frac{\partial w_r}{\partial \delta}\frac{du_g}{dx} + \frac{\partial w_g}{\partial \delta}\frac{du_r}{dx}}{(1-L_w^*)\frac{d^2u_g}{dx^2} + 2\frac{du_r}{dx}\frac{du_g}{dx} + (u_g(x^*) - w_g)\frac{d^2u_r}{dx^2}} \tag{23}$$

The Impact of the Atrocity Tax, τ

. . . on α^*

The equilibrium level of atrocities is, once more,

$$\alpha^* = \sqrt{\frac{m_r + h_r}{(1-\delta)(k_g + \tau)}} - \frac{m_g + m_h + h_r}{1-\delta}$$

By inspection, we can see that increasing τ decreases α^*, so raising the tax on atrocities lowers the level of atrocities committed.

. . . on L_w^*

The analysis is the same as before. The likelihood of war is

$$L_w^* = p_r(h_r, \alpha^*) - k_r\alpha^* - u_r(x^*)$$

The derivative with respect to τ is

$$\frac{\partial L_w^*}{\partial \tau} = \frac{\partial p_r}{\partial \alpha}\frac{\partial \alpha^*}{\partial \tau} - k_r\frac{\partial \alpha^*}{\partial \tau} - \frac{du_r}{dx}\frac{\partial x^*}{\partial \tau}$$

The first term is positive, since raising τ will lower the level of atrocities, which makes the rebels more likely to win. The second term is also positive, since lowering the level of atrocities will benefit the rebels.

We can reexpress this as follows:

$$\frac{\partial L_w^*}{\partial \tau} = \frac{\partial w_r}{\partial \tau} - \frac{du_r}{dx}\frac{\partial x^*}{\partial \tau} \tag{24}$$

The rebels's utility increases with x. That leaves the impact of τ on the equilibrium offer. Returning to the first order condition with x^* substituted in

$$(1 - L_w^*)\frac{du_g(x^*)}{dx} + (u_g(x^*) - w_g)\frac{du_r(x^*)}{dx} \equiv 0 \tag{25}$$

this time we take the derivative with respect to τ.

$$\begin{aligned}
(1 - L_w^*)\frac{d^2u_g(x^*)}{dx^2}\frac{\partial x^*}{\partial \tau} & \\
-\frac{\partial L_w^*}{\partial \tau}\frac{du_g(x^*)}{dx} & \\
+(u_g(x^*) - w_g)\frac{d^2u_r(x^*)}{dx^2}\frac{\partial x^*}{\partial \tau} & \\
+\left(\frac{du_g}{dx}\frac{\partial x^*}{\partial \tau} - \frac{\partial w_g}{\partial \tau}\right)\frac{du_r(x^*)}{dx} &= 0
\end{aligned}$$

Expanding two terms,

$$\begin{aligned}
&(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}\frac{\partial x^*}{\partial \tau} \\
&-\left(\frac{\partial p_r}{\partial \alpha}\frac{\alpha^*}{\partial \tau}-k_r\frac{\partial \alpha^*}{\partial \tau}-\frac{\partial u_r}{\partial x}\frac{\partial x^*}{\partial \tau}\right)\frac{du_g(x^*)}{dx} \\
&+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}\frac{\partial x^*}{\partial \tau} \\
&+\left(\frac{du_g}{dx}\frac{\partial x^*}{\partial \tau}-\left(\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial \tau}-k_g\frac{\partial \alpha^*}{\partial \tau}\right)\right)\frac{du_r(x^*)}{dx} \quad = \quad 0
\end{aligned}$$

then isolate $\frac{\partial x^*}{\partial \tau}$,

$$\begin{aligned}
&\frac{\partial x^*}{\partial \tau}\left((1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}+\frac{\partial u_r}{\partial x}\frac{\partial u_g}{\partial x}+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}+\frac{\partial u_r}{\partial x}\frac{\partial u_g}{\partial x}\right) \\
&\quad=\left(\frac{\partial p_r}{\partial \alpha}\frac{\alpha^*}{\partial \tau}-k_r\frac{\partial \alpha^*}{\partial \tau}\right)\frac{du_g(x^*)}{dx}\left(\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial \tau}-k_g\frac{\partial \alpha^*}{\partial \tau}\right)\frac{du_r(x^*)}{dx}
\end{aligned}$$

and solve for it.

$$\frac{\partial x^*}{\partial \tau} \quad = \quad \frac{\left(\frac{\partial p_r}{\partial \alpha}\frac{\alpha^*}{\partial \tau}-k_r\frac{\partial \alpha^*}{\partial \tau}\right)\frac{du_g(x^*)}{dx}+\left(\frac{\partial p_g}{\partial \alpha}\frac{\partial \alpha^*}{\partial \tau}-k_g\frac{\partial \alpha^*}{\partial \tau}\right)\frac{du_r(x^*)}{dx}}{(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}+2\frac{\partial u_r}{\partial x}\frac{\partial u_g}{\partial x}+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}}$$

This can be reexpressed as the following:

$$\frac{\partial x^*}{\partial \tau} \quad = \quad \frac{\frac{\partial w_r}{\partial \tau}\frac{du_g}{dx}+\frac{\partial w_g}{\partial \tau}\frac{du_r}{dx}}{(1-L_w^*)\frac{d^2u_g(x^*)}{dx^2}+2\frac{\partial u_r}{\partial x}\frac{\partial u_g}{\partial x}+(u_g(x^*)-w_g)\frac{d^2u_r(x^*)}{dx^2}}$$

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The assertions, opinions, and conclusions in this occasional paper are those of the author. They do not necessarily reflect those of the United States Holocaust Memorial Museum.

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