Understanding Atrocity Crimes and Their Prevention: A Base Model

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Abstract: Purposefully conducted episodes of genocides and other mass atrocities (GMAs) are geographically widespread, surprisingly frequent, severely destructive in the present moment, and long-lasting in their effects for follow-on generations. Despite this, few economists have engaged the topic. Fewer still have given thought to how GMAs might be prevented. Focusing on GMA architects, we develop a foundational model that describes the architects' objective function and a set of economic, psychological, and sociological constraints under which they choose a behavior. Using specific functions, we simulate the model numerically and find that to end, mitigate, or prevent episodes of GMA requires drastic impositions on the parameters that characterize the constraints. We then discuss various extensions that would make the base model more descriptive and general and that might reveal more effective pathways to GMA prevention.

Keywords: Genocide, mass atrocities, atrocity crime prevention, comparative statics, simulation

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1. Introduction

Between 1900 and 2016, there have been more than 200 documented genocides and other mass atrocities (GMAs) in which *governments* deliberately killed at least 1,000 noncombatant civilians over a period of sustained violence (Anderton 2016). Depending on how one counts, these geographically widespread and economically long-lingering episodes of GMAs have led to between 80 to 240 million noncombatant civilian deaths, that is, not counting injuries, military casualties, or mass atrocities committed by *nonstate* forces (of which at least 35 can be documented from 1989 to 2016). The severity of GMAs relative to other forms of violence is striking. For example, estimated fatalities totaled over only four genocides (Cambodia 1975-1979, Pakistan 1971, Sudan 1983-2002, and Rwanda 1994) surpass the total estimated military fatalities for the 239 civil wars fought since 1900. Moreover, data provided by the National Consortium for the Study of Terrorism and Responses to Terrorism imply that more people were killed in just *six weeks* at the height of the 1994 Rwandan genocide than were killed in all international and domestic terrorist incidents worldwide in the more than 45 years since 1970. Many economists may be unfamiliar with the extensive literature theorizing and documenting the sundry economic aspects of GMAs, in part because such work is scattered across academic disciplines, economics sub-disciplines, and field journals. That the grave problem of mass atrocities and its economic dimensions seems to be relatively unknown to many economists represents a significant opportunity for the profession to learn more about this scourge to human welfare and to leverage its rich concepts and theories to promote GMA prevention.

The starting point in any attempt to understand GMAs, economic or otherwise, is: why do such atrocities happen? Speaking of ethnic violence (which would include many GMAs), former U.S. Secretary of State Lawrence Eagleburger said: “There is no rationality at all about ethnic conflict. It is gut, it is hatred; it's not for any common set of values or purposes; it just goes on" (quoted in Power 2002, p. 282). Our starting point, however, is just the opposite of Eagleburger's. We claim that GMAs are *purposeful* and instrumentally *rational*, i.e., they are *deliberately chosen* by political leaders to achieve one or more objectives. One key question addressed by our article is: *Why* would political leaders choose a GMA pathway, rather than another? A second key question is: Given the conditions under which political leaders would be inclined to choose GMA, what policies and programs by state and non-state actors can diminish (and even eliminate) the likelihood of such a choice?

To address our key questions, this article offers initial elements of a base or foundational model in which one or a small group of political leaders finds it in their interest to become *architects* of GMA. We focus on the objective function of the political leaders, which considers their desire to acquire typical consumer goods such as food, clothing, and shelter, but also to acquire, enhance, or prevent their loss of dominance or monopoly power over a potentially or actually contested "good" such as the polity, territory, and/or the society's ideological or identity "terrain." Many political leaders today and throughout history have achieved such dominance without becoming architects of a GMA. Hence, the constraints (resource and otherwise) coupled with the leaders' objective function will be important features of the base model. The constraints will affect the conditions under which the political leaders' attempts to achieve dominance by other means fail, leading them to become architects along a GMA pathway.

Our article is organized as follows. In Section 2 we focus on the potential for political leaders to become GMA architects. (We will leave for another article the modeling of the choices and behavior of the non-architects.) Toward this end we construct a base model of reference-dependent, loss-averse, and identity-conscious political leaders. Subject to a resource constraint, and the behavior of other actors, they seek dominance over a key strategic or political good. While dominance seekers are prevalent throughout the world, GMAs only result occasionally, so in Section 3 we use numerical simulations of the base model to identify the conditions in which GMA architects would have a positive demand for GMA. In Section 4 we discuss implications of the base model for genocide prevention and explore model extensions which include directions for future research on modeling mass atrocity risks and prevention. Section 5 concludes. Two appendices provide definitions of and distinctions among genocide, other mass atrocities, civil war, and terrorism as well as supplementary simulation results.

2. GMA Architect: A Base Model

Numerous actors are involved in the development of a GMA. They include the architects, managers, on-the-ground perpetrators, bystanders, resisters, victims, and potential third party interveners. In this article, however, our focus will be on the potential for political leaders to become GMA *architects*. We thus take as given the various potentials for non-architects to go along with or resist the architects' consideration of a GMA program. Hence, the behavior of these and other actors will serve as constraints (along with a resource constraint) on the choices of potential GMA architects. The model we present is highly stylized and is built using both general and specific functional forms. We begin with several GMA stylized facts that characterize aspects of GMAs that our model will capture.

Stylized Facts Regarding GMA and GMA Architects

<u>Fact 1</u>. GMA architects' seek dominance of control over territory, polity, and/or society's governing ideology or identity. Dominance need not extend to 100 percent control (pure monopoly); it only needs to be or become "sufficient" or "effective" control.

Fact 2. GMAs are not spontaneous random acts of violence but tend to be purposeful. They are rational in the sense that GMA architects face resource constraints subject to which they make the best possible, or optimal, choice given their objectives. For example, if social control is the objective and killing perceived opponents is (made) relatively cheap, then more killing will be chosen than when killing is (made) relatively expensive.

Fact 3. The (disturbing) rationality of GMA does not preclude non-rational elements in fostering the planning and execution of GMA, particularly reference dependence and loss aversion. The former refers to a degree of dominance at or above which social control is viewed to have been achieved and below which it has not (e.g., a target rate of ethnic homogeneity to be achieved). The latter refers to the idea that GMA architects may view downward departures from the reference point as a more severe "failure" than any corresponding upward gain is viewed as a "success."

Fact 4. The contest between two or more parties over dominance includes contestation over persons' self-understood or manufactured identity as well as the potential use of violence against civilians.

Fact 5. Once GMAs commence, they are hard to stop, ceasing only when the killers have "killed enough" (Conley-Zilkic and de Waal 2014, p. 60).

Reference Dependent Utility Function and Loss Aversion

The potential GMA architects are modeled as a singular player A, who obtains ordinal utility from consumption goods, which we treat as a composite good C. (We assume the requirements of the composite goods theorem hold.) Player A also obtains utility from dominance good Q (e.g., political, territorial, or ideological control). We assume good Q is a *reference dependent* good in which value is realized for A based upon the amount of the dominance good achieved by

A, Q_A, relative to a reference point of Q, designated $\tilde{Q}$, which is a parameter (Cartwright 2011, pp. 47-49; Kőszegi and Rabin 2006). Behavioral economists have provided evidence from laboratory experiments that decision-makers are often *loss averse*. Specifically, relative to a reference point such as a level of wealth or status, agents will often magnify the value or importance of a loss more than they would assess the value of an equivalent gain (Kahneman, Knetsch, and Thaler 1991; DellaVigna 2009). Thus, also assume player A is stung in a magnified manner when the level of dominance falls short of a reference level of dominance. A general and specific utility function that captures these assumptions is:

$$(1)\ U(C,Q) = u\left[C, v\left(Q\middle|\tilde{Q}\right)\right] = \begin{matrix} \mathrm{A}C^{\alpha} + \left(Q_A - \tilde{Q}\right)\ if\ Q_A - \tilde{Q} \geq 0 \\ \mathrm{A}C^{\alpha} + \lambda\left(Q_A - \tilde{Q}\right)\ if\ Q_A - \tilde{Q} < 0,\ \lambda > 1 \end{matrix}\quad \mathrm{A} > 0, 0 < \alpha < 1.$$

The λ parameter in (1) captures the degree of loss aversion to A when the level of dominance, Q_A, falls below the reference point level of dominance, $\tilde{Q}$ (Cartwright 2001, p. 121). By making λ>1, losses enter utility asymmetrically relative to gains. The other parameters (A, α) determine how the amount of the consumption good translates into utility.

Production of and Contestation Over Q

The consumption good, C, can be purchased in the marketplace at unit cost or price, P_c. The dominance good, however, is not something to be bought in the market. Instead, player A attempts to *produce* Q_A by allocating resources to create dominance, but Q_A is also often generated in *contestation* in which player A struggles with one or more other groups that would also like to acquire dominance. Assume that player A is in a contest with player B for dominance. Player B can be a key group or a composite of groups in contestation with A. Such contestation can occur *directly* between A and B in the form of fighting between their regular forces as well as *indirectly* as each side seeks to manipulate civilians to support their dominance. Assume the portions of Q accruing to each player in the contest, Q_A and Q_B, are determined by a contest success function (CSF) (Hirshleifer 1991, 1995; Skaperdas 1996). A general and two specific CSFs (ratio form and logistic) determining player *A*'s portion of *Q* can be specified as follows:

$$(2) \qquad Q_A = Q\rho_A(M_A, M_B) = \begin{cases} Q\left(\frac{M_A}{M_A+M_B}\right) & ratio \\ Q\,\frac{1}{1+exp(M_B-M_A)} & logistic \end{cases} ,$$

where M_i (i=A,B) is *i*'s power or strength in the contest, ρ_A is the proportion of the contested item *Q* received by *A*, and Q_A is the amount of *Q* controlled by *A*. The proportion of *Q* controlled by *B* is 1- ρ_A.[1]

Player *A*'s strength in the contest for dominance, M_A, in turn is determined by *A*'s regular fighting effort (or threat to fight) against *B*, denoted F_A, by *A*'s investment in group solidarity or identity to shore up its own social group support, I_A (Akerlof and Kranton 2000; Murshed and Tadjoeddin 2016), and also by *B*'s violence or intimidation against civilians, ω, designed to undermine *A*'s civilian support structure. A general and specific functional form consistent with these assumptions is:

$$(3) \qquad M_A = f(F_A, I_A, V_B) = \psi F_A^f + \theta I_A^\iota - \omega ,$$

where the additional items on the right side of the second equals sign are parameters. Similarly, player *B*'s strength in the contest, M_B, is given by:

$$(4) \qquad M_B = f(\bar{M}_B, V_A) = \bar{M}_B - \Phi V_A^\nu ,$$

where $\bar{M}_B$ is a given amount of strength of *B* and V_A is *A*'s violence against civilians designed to undermine *B*'s civilian support structure. The other items on the right side of the second equals sign in (4) are parameters.

Resource Constraint

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[1] Equation (2) can also be $Q\rho_A(1\text{-}\delta)$ where δ is the proportion (e.g., 0.1) of the contestable item destroyed or dissipated in the contest. A positive delta can be a potential source of negotiated settlement because each side can potentially gain from avoiding the dissipation costs of fighting.

Player *A* has the following resource constraint:

(5) $R_A = P_c C + P_f F_A + P_I I_A + P_v V_A$.

In equation (5), R_A represents the amount of resources available to *A* for consumption goods and acquiring power via fighting effort, identity formation, and violence against civilians according to the average or unit costs of such items, P_i ($i = C, F, I, V$).

Constrained Optimal Choice and Demand Functions

Player *A*'s optimal choice problem then is to choose C, F_A, I_A, and V_A to maximize utility in (1) subject to (2), (3), (4), and (5) assuming *B*'s choices are given. This constrained utility maximization problem gives rise to *A*'s demand functions for the choice variables (C, F_A, I_A, V_A). Put differently, in a 2-dimensional setup, which is where our model starts for simplicity, the corner solution of no violence against civilians (V=0) is a potential pathway for leaders to take, as is a non-corner solution with an amount of *V* that would not reach most scholars' threshold for GMA (V>0) or a larger amount of *V* that would (V>>0). The main research question is: why is the non-killing pathway not taken, and a pathway either of "regular" contestation (killing that does not amount to GMA) or of degenerate contestation (killing that does amount to GMA) is chosen instead?

3. The Architects' Demand for Violence against Civilians

In this section we focus on player *A*'s demand characteristics for violence against civilians, V_A. When a positive demand exists (V_A^*>0), we would like to know the conditions in which violence against civilians will rise or fall (comparative statics). In the next section (GMA prevention), we focus on conditions in the model in which the optimal amount of violence against civilians is zero ($V_A^* = 0$).

Baseline Simulation

Short of an analytic solution, the first row of Table 1 provides simulations of the model from the previous section for an initial set of arbitrary numerical values for the parameters assuming the ratio version of the CSF in (2). We call row 1 of Table 1 the "baseline simulation." In the baseline, and given the constraints, the optimal amount of violence against civilians (VAC) chosen by *A* is $V_A^* = 7.4$. Optimal values are denoted with an asterisk (*). The optimal amounts of the other choice variables are C*=104.4, F_A^*=44.1, and I_A^*=44.1. Given that fighting effort and group identity formation enter as separable in equation (3) *and* that the parameter values attached to each are the same in the simulation, we would expect F_A^* and I_A^* to be the same.

[Table 1 here]

Law of Demand

Rows 2-4 of Table 1 relative to the baseline show that the potential architects' demand for VAC obeys the law of demand. Specifically, as the price or average cost per unit of attack against civilians rises, the number of such attacks falls, everything else the same. While we assume that the average cost per attack is given (exogenous) in the model, in a more elaborate specification it would be determined by such factors as the concentration or density of civilians per unit of area, the terrain or geography of the area (e.g., mountains, jungles, cities, rural), the road networks and hubs for tracking down civilians, and the willingness of the population to resist (or go along with) the GMA architects (Zhukov 2016). Note also in rows 2-4 that violence against civilians and the other contestation variables, F_A^* and I_A^*, are gross substitutes. An increase in the price of attacking civilians leads to greater fighting effort, F_A^*, and investment in identity formation, I_A^*, everything else the same.

Normal Good

Rows 5 and 6 of Table 1 relative to the baseline show that VAC is a normal good. Specifically, as the income or resources, R_A, available to player *A* increases, the optimal amount of VAC goes up, everything else the same. Note that the other contestation variables F_A^* and I_A^*, also are normal goods.

The Architects' Fighting Cost

Suppose third parties choose to help player *B* in its contest with *A* by raising the unit cost of direct fighting, P_f. This might occur, for example, with an arms embargo against *A*. Row 7 of Table 1 shows the effects of the higher cost of direct fighting on *A*'s optimal choices. The row shows that violence against civilians is virtually unchanged, fighting effort falls significantly, and identity formation effort increases significantly. When we simulated the effects of an increase in P_f under the assumption of logistic contest technology (see row 7A of Appendix Table A1), we found that fighting effort once again fell significantly, identity formation effort rose significantly, but the optimal amount of violence against civilians *rose*.[2] Hence, in our simulations, third party efforts to raise the cost to *A* of direct fighting did not help, and could even worsen, violence against civilians.

Increase in the Price of Civilian Goods

Suppose third parties place a civilian goods embargo against *A*, which serves to raise the price of civilian goods in *A*'s society, all other parameters held constant. Row 8 of Table 1 shows that direct fighting effort, identity formation, and violence against civilians all rise.

The civilian goods and arms embargoes summarized in this and the preceding sub-section suggest that well-meaning third party efforts to punish badly behaving regimes have the potential

[2] The simulations across Tables 1 and A1 involve more than a change in the contest success function (CSF) from ratio to logistic. Some initial and new parameter values differ across the tables. Different values were used for some of the parameters in Table A1 relative to Table 1 to achieve a wide range of outcomes under a logistic CSF in which loss aversion behavior would occur (as it did in Table 1).

to not help, and may even hurt, civilians at risk of atrocity, a backfire condition also identified in Anderton and Carter (2005), Anderton and Brauer (2016b), and Esteban, Morelli, and Rohner (2016). Hence, the recent civilian goods sanctions and arms embargo urged by the USA against South Sudan (see Reuters 2016) would not necessarily have salutary effects for at-risk civilians in the context of contestation for dominance in the country. More broadly, the widespread view that such sanctions will help vulnerable civilians is not a given when seen through the lens of economic choice theory. As we will argue in the section on GMA prevention later on, more holistic policy approaches are required given the many substitution possibilities present in GMA contexts.

Productivity of Attacks Against Civilians

One surprising result of the model is how sensitive is the demand for VAC to increases in the productivity parameter on attacking civilians, υ. In rows 9-12, notice how small increases in υ (from 0.25 in the baseline to 0.3, 0.4, 0.43, and 0.438) lead to ever larger increases in the optimal amount of attacks against civilians (from 7.4 to 11.6 to 38.5 to 76.2 to 122.8). Indeed, what we find with further increments to υ is that violence against civilians begins to crowd out other activities (C*, F_A^* and I_A^*). When attacking civilians becomes a major form of *A*'s contestation behavior, we cross into what Shaw (2003, p. 5; 2015, p. 131) calls "degenerate war." At sufficiently high values of υ in our simulations, the GMA architects begin to carry out what appears to be extreme degenerate war in which "regular" fighting and identity formation give way to contestation by VAC means alone.

The Architects' Direct Fighting Productivity

Suppose third parties choose to help player *B* in its contest with *A* by decreasing player *A*'s productivity in direct fighting, *f*. Such a policy might occur, for example, when landmines or military advisors are provided to *B* to diminish *A*'s fighting abilities. Rows 13 and 14 of Table 1 show the effects of reductions in *A*'s fighting productivity parameter. Results show that the "squeezing" of *A*'s direct fighting abilities leads to greater violence against civilians, which again highlights the possibility that well-meant intervention can backfire.

Increase in B's Military Stock

In rows 15 and 16, *B*'s military stock, $\bar{M}_B$ is increased, which serves to strengthen *B* in its contest with *A* as distinct from weakening *A* in its contest with *B*. Relative to the baseline case, rows 15 and 16 show that violence against civilians decreases. This result, however, is not general. Similar simulations under logistic conflict technology show that increases in *B*'s military stock lead to counterproductive increases in violence against civilians (rows 15A and 16A in Appendix Table A1).

Increase in A's Reference Level of Control

The simulation in row 17 in Table 1 shows that an increase in *A*'s reference level of control, $\tilde{Q}$, has no effect on the optimal levels of the choice variables. This result is an artifact of the utility function in (1) in which $\tilde{Q}$ enters as a constant in the loss aversion portion of the utility function. Obviously, a more complex specification of loss relative to a reference point (e.g., losses increase at an increasing rather than linear rate) would alter this outcome. We have chosen the specification in (1) because it is a simple starting point.

Increase in the Degree of Loss Aversion: The Kahneman-Tversky Curve

Finally, in rows 18-20 of Table 1, we show the effects of an increase in *A*'s degree of loss aversion from λ=3 in the baseline simulation to λ values of 4, 5, and 6. Not surprisingly, greater loss aversion sensitivity leads to more direct fighting, identity formation, and violence against civilians as VAC rises from 7.4 in the baseline to 9.5 to 11.3 and to 12.8. Analogous to how an

Engel curve depicts a relationship between income and the amount demanded of a good, everything else the same, we plot in Figure 1 a Kahneman-Tversky (KT) curve, named after two pioneering behavioral economists, Daniel Kahneman and Amos Tversky. The KT curve shows the relationship between the degree of loss aversion, λ, and the amount of VAC demanded given the parameter values of the baseline simulation. In the next section, we use the KT curve to identify the conditions in which it ceases to exist, i.e., the conditions in which GMA architects will choose zero VAC.

[Figure 1 here]

4. Discussion: Implications for Prevention Policy and Possible Extensions

4.1 Discussion

A question that now arises naturally is this: in the stylized model, under what conditions would attacks against civilians be zero? This corresponds in Figure 1 for any given degree of loss aversion, for example λ=3, to the KT curve intersecting the vertical axis at that value of λ. Table 2 provides suggestive answers to what in effect becomes the question of GMA prevention. Relative to the baseline case (simulation 1), simulation 21 shows that it would take an extremely high price or unit cost of attacking civilians (P_v=100 in the table) for the optimal amount of civilian killing to be virtually eliminated. Row 22 provides a similarly pessimistic result, namely that a dramatic decline in resources (90 percent decline in R_A from 1000 to 100) to the architects would be necessary for civilian killing to approach zero, everything else the same. Moving to simulation 23 we see that a drastic cut in the unit cost of the architects' direct fighting from P_f of 5 to 0.1 causes optimal civilian killing to decline, but only by about half relative to the baseline case. Furthermore, consider the 98 percent decline in the price of civilian goods (from P_c of 5 to 0.1) and the 96 percent decline in the productivity parameter associated with killing civilians (from υ of 0.25 to 0.01) as shown in simulations 24 and 25, respectively. These simulations do show a significant decline in civilian killing, but even these dramatic parameter changes are insufficient to collapse civilian killing all the way to zero. Simulations 26, 27, and 28, also show, respectively, declines in optimal killing of civilians for a greater productivity for the GMA architects in direct fighting (from f of 0.5 to 1.5), greater arms provisions for the rebel group B (from $\bar{M}_B$ of 10 to 50), and the reduction of the psychological phenomenon of loss aversion (from λ of 3 to 1). Nevertheless, once again, civilian killings do not collapse to zero for these relatively large parameter changes. Taken as a whole, then, the initial simulation results add another dimension to Anderton and Brauer's "*bleakness theorem* according to which perpetrators can overcome piecemeal GMA prevention efforts owing to extensive substitution possibilities across means of genocide" (2016a, p. 17).

The final simulation (29) in Table 2 reflects an alteration of the loss aversion portion of the utility function in equation (1). As indicated in note 4 of Table 2, the utility function is modified such that there is diminishing marginal utility associated with loss aversion. The assumption does not reflect the reduction or removal of loss aversion (λ=3 in simulation 29), but a diminishing effect on the architects' *marginal* utility loss associated with falling short of the reference level of Q. This is the one simulation in Table 2 in which it is fairly easy to collapse optimal civilian killing in the model without invoking dramatic changes in parameters. Whether this simulation may have empirical relevance is an open question. There is strong empirical evidence in behavioral economics for loss aversion, but do such magnified utility effects from losses get magnified even further at the margin or do those magnified effects diminish at the margin? If the former, and coupled with the other simulations in Table 2, our "demand function" model of civilian killing has little good news to report regarding policies to collapse civilian killing to zero, at least under the stylized assumptions of the model including the ratio form CSF. If the latter, then there is at least one path by which one can imagine an optimal amount demanded of civilian killing at zero which does not require heroic assumptions on parameter values.

[Table 2 here]

In Appendix Table A2 we address the issue of the conditions under which attacks against civilians would be zero, but for the logistic contest success function. Most results in Table A2 are similar to those in Table 2 in requiring draconian changes in parameters for civilian killing to approach zero. There are, however, two exceptions; halving the architects' resources (from R_A of 500 to 250) and a little more than doubling the architects' fighting productivity parameter (from f of 0.5 to 1.1) each led to essentially zero acts of civilian killing. These two "exceptions" still require relatively large parameter changes.

4.2 Extensions

In this subsection, we discuss a limited number of possible extensions of our base model which, we hope, researchers will take up in future.

Architects, non-architects, and other groups. Our base model focuses on the choices and behavior of potential GMA architects, modeled as a unitary actor. Some real-world cases of GMA certainly suggest that a unitary actor is at work. In other cases, multiple architects are at work and in modeling the group's collective decision-making, it may be possible to exploit differences and tensions within the group or between the group and an immediate outer layer of managers to whom GMA tasks are delegated to help end, mitigate, or prevent GMA (see, e.g., Caruso 2016). Even when conceived as a unitary actor, however, one important constraint facing potential GMA architects, or its immediate managers, is the recruitment of GMA *perpetrators* (i.e., the on-the-ground personnel or "foot soldiers") as well as the nullification of *resisters* who will actively oppose the GMA. As it is not possible (outside of a weapon of mass destruction) for GMA architects to destroy thousands or even millions of civilians on their own, GMAs generally require the tacit or explicit participation of thousands of "ordinary people" who become part of an "industry" designed to destroy people. Such people also *deliberately choose*, subject to the constraints they face, either to go along with a GMA program (*perpetrators* who actively participate) or to look the other way (*bystanders* who tacitly participate). Similarly, the feasible choice set of potential third party GMA preventers or interveners would need to be brought into the base model as would the choice set of victims whose behavior in particular seems vastly understudied in the genocide and mass atrocities literature (Brauer and Caruso 2016).

Scale, scope, and agglomeration effects. Table 1 highlights comparative static results showing, for instance, that a lower price of violence, P_c, leads to higher levels of killing and that greater productivity of VAC also leads to higher levels of killing, *ceteris paribus*. However, it is likely that economies of scale, scope, and density (e.g., herding victims into camps) leads to productivity increases that, in turn, reduces the price or average unit cost of killing to GMA architects. This potential interaction of productivity and cost could be explicitly modeled to learn about the strength of this interaction and whether some aspects of productivity and unit cost are amenable to change by resisters or third parties (without triggering a backfiring adaption by GMA architects).

Shifting reference levels of control $\tilde{Q}$ and a taste for Q. It is possible that a ratchet, or hysteresis, effect sets in whereby each actually achieved level of control, Q, becomes the new reference-dependent point, $\tilde{Q}$, for the next time period. (As mentioned in the main text, we model the reference level of control as a constant. In reality this need not be the case and more complex formulations could be explored.) In addition, it is possible that GMA architects acquire a "taste" for Q whereby Q no longer is merely an item to be produced, as we have modeled it, but itself becomes an item of increasingly sophisticated *consumption* as GMA architects "invest" in achieving ever higher levels of destruction akin to the way a lover of classical music may invest in achieving ever higher levels of music enjoyment. Waller (2016) describes a number of such instances and Anderton and Ryan (2016) offer theoretical and empirical support for the notion of habituation to civilian killing. It may be possible to model this in the manner of Stigler and Becker (1977) and the subsequent literature on the economics of habituation and addiction.

The cost of contestation. We noted that the left-hand side term of equation (2) could be written as $Q\rho_A(1\text{-}\delta)$ where δ is the proportion (e.g., 0.1) of the contestable item destroyed or dissipated in the contest. A positive delta can be a potential source of negotiated settlement because each side can potentially gain from avoiding the dissipation costs of fighting. To these direct costs one could add the destructive costs of indirect or degenerate contestation. Taken together, this would imply three pathways to achieve the goal of Q: (1) a negotiated settlement (peace), (2) a "negotiated" way to fight a "regular" direct war (i.e., keep hands off civilians), and (3) war, including degenerate war.

Alternative ways to achieve or resist dominance, Q. Our model focuses on the optimal number of civilians killed through use of violence, V, and fighting, F, as partial measures of power or strength, M. (The model does not focus on the many ways in which killing can be accomplished such as outright killing, mass starvation, work-to-death camps, and so on, added complexities on which see Anderton and Brauer 2016b). Dominance, however, can be achieved in non-fighting and non-killing ways as well, for example through genuine integration and homogenization (making friends of perceived enemies), just as resistance to dominance may be achieved in non-violent ways. It is in this arena that perhaps great advances can be made by further elaboration of the socio-psychological factors in the model, that is, the largely perceptual factors of identity formation, reference point selection, and loss aversion. If, normatively, we want non-killing – or, indeed, peace! – future models will need to explicitly allow for potentially desired behavior rather than the mere reduction or absence of unwanted behavior such as killing.

Stoking love or hate. In the spirit of Murshed and Tadjoeddin (2016), it may be possible to model I_A in equation (3) as, in our notation, $I_A = I_A (s_A, s_B, \mu)$. The parameter s_i refers to actions related to party *i*'s primary identity (for example, as a member of a majority ethnic group) and flows into that party's utility function, say *A*'s. Importantly, actions taken by party *B* (i.e., s_B) contribute to how a member of *A* perceives his/her own primary identity. Moreover, so does the parameter μ, which is a love (<0) or hate (>0) parameter that can soften or embellish *A*'s primary identity and, to an extent, can be manipulated by GMA architects or their managers (or by resisters or third parties) (see also Petrova and Yanagizawa-Drott 2016).

B's strength: Similarly, in equation (3) we presented *B*'s option as one of violence or intimation to sap the civilian support of player *A*. But moral or other appeals and means also may work, not just (counter) violence or threat thereof. Thus, one could think of *V*(*B*) as a variable with a parameter that can be >0 or <0 depending on whether or not there is an incentive (or disincentive) for *A*'s social group to resist *A* and cooperate with *B*.

Strategic behavior: Cournot or Bertrand? Maximizing (1) subject to constraints (2), (3), (4), and (5) implies an assumption regarding capacity constraints, for example the capacity to kill or to sabotage killing. In economists' industrial organization literature, two competing firms' production capacity may be fixed so that the joint degree to which their capacity is used determines the price at which the combined level of production is sold on the market (the

Cournot case). If, however, production capacity is not effectively constrained by any upper limit, then increasing production leads to lowered market prices (the Bertrand case). Either case can give rise to different strategic behaviors in stage 1 to achieve a desired outcome in stage 2. For examples of strategic aspects, see Fudenberg and Tirole (1984), generally, and Esteban, Morelli, and Rohner (2016), for GMA specifically, but clearly our base model should be extended to permit strategic behavior.

Business, civil society, and institutions. Only implicitly do we tackle the actual and potential roles played by business and civil society organizations, and institutions more generally, that is, inasmuch as they all enter the model exogenously to shift *A*'s and *B*'s tactical decision variables such as the price of fighting or resource availability. In the future, it may well pay great dividends for GMA prevention if the role and behavior of these additional actors can be endogenized, at least in part.

5. Conclusion

It should now be clear that economics as an academic discipline would seem highly relevant to probe, elucidate, and possibly help end, mitigate, or even prevent atrocity crimes, which are a human problem of massive proportions. Yet, curiously, there exists both an "economics gaps" in the genocide literature as well as a "genocide gap" in the economics literature (Anderton 2014). Despite the immensely sad nature of our topic, inasmuch as economics is about discovering and advancing ways of human development and betterment, we cannot think of a more worthy subject matter to study.

Appendix: Definitions

This Appendix provides definitions of and distinctions between and among genocide, other mass atrocities, civil war, and terrorism. Article 2 of the 1948 United Nations (UN) Convention on the Prevention and Punishment of the Crime of Genocide defines *genocide* as "any of the following acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, as such: (a) Killing members of the group; (b) Causing serious bodily or mental harm to members of the group; (c) Deliberately inflicting on the group conditions of life calculated to bring about its physical destruction in whole or in part; (d) Imposing measures intended to prevent births within the group; (e) Forcibly transferring children of the group to another group" (United Nations 1951). Contrary to popular belief, genocide thus need not involve any killing at all, although it usually does. Nor do all mass killings constitute genocide, as genocide requires intent to destroy a group of people as such (Waller 2007, p. 14). Crimes distinct from but often associated with genocide and mass killing include war crimes and crimes against humanity. Collectively, legal scholars refer to these crimes as atrocity crimes. Including ethnic cleansing, we categorize all such crimes under the more general heading of mass atrocities.

Crimes against humanity are systematic attacks against civilians involving inhumane means such as extermination, forcible population transfer, torture, rape, and disappearances. *War crimes* are grave breaches of the Geneva Conventions including willful killing, willfully causing great suffering or serious injury, extensive destruction and appropriation of property, and torture. *Ethnic cleansing* is the removal of a particular group of people from a state or region using such means as forced migration and/ or mass killing (Pégorier 2013). Ethnic cleansing is not, however, defined as an atrocity crime under the Rome Statute of the International Criminal Court.

After a thorough review of previous definitions and conceptual issues, Sambanis (2004, pp. 829-830) defines *civil war* as armed combat between a functioning government and one or more politically and militarily organized rebel groups located (territorially based) within the country of the government in which combat causes at least 500 deaths in the first year and at least 1,000 cumulative deaths within three years. Sambanis adds further provisos to his characterization of civil war including that the weaker party must be able to mount effective resistance (i.e., at least 100 deaths inflicted on the stronger party), otherwise there is no civil war and the killing is politicide or other form of one-sided violence.

Enders and Sandler (2011) define *terrorism* as “the premeditated use or threat to use violence by individuals or subnational groups to obtain a political or social objective through the intimidation of a large audience beyond that of the immediate victims” (p. 4). Terrorism is both a form of conflict and a tactic of conflict used in wars and mass atrocities.

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Figure 1: Kahneman-Tversky Curve

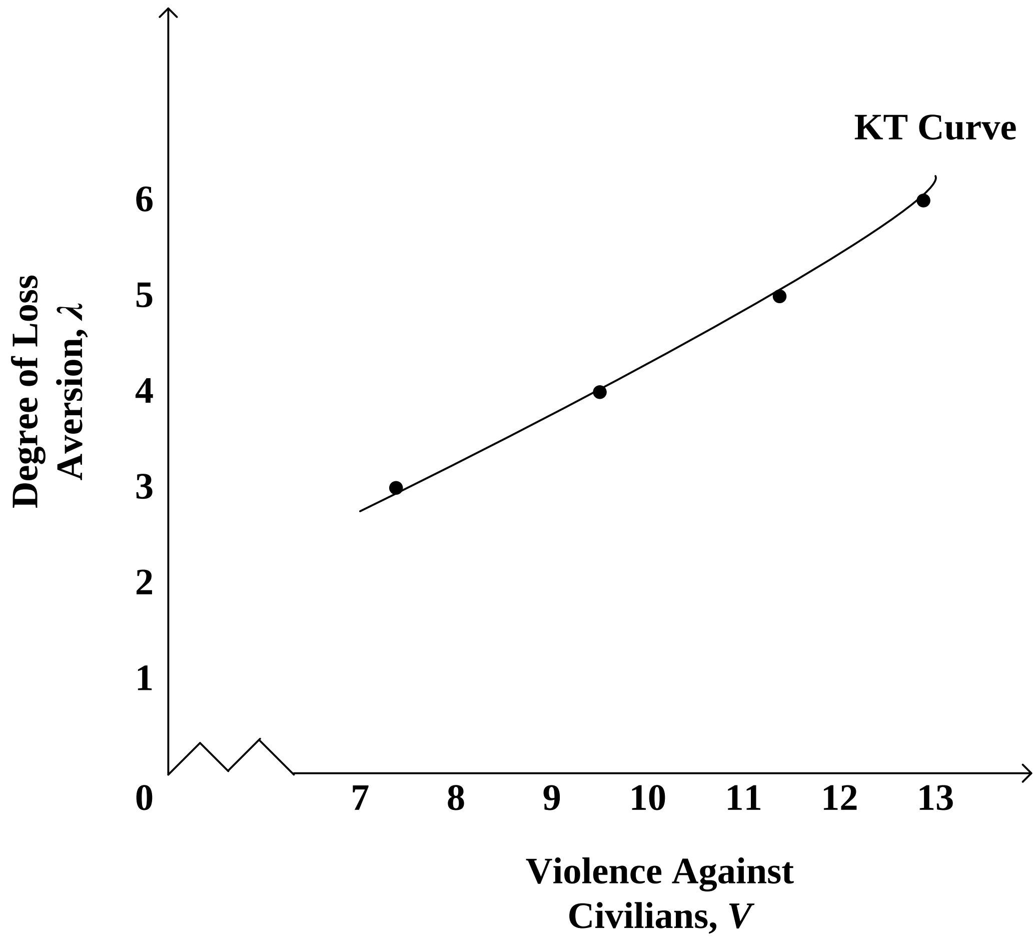

Table 1: Simulations of Architect's Demand for Atrocity (Assuming Ratio-form Contest Success Function)

Case	Price of *V* (P_V)	Resources (R_A)	Price of *F* (P_f)	Price of *C* (P_c)	Prod. on *V* (υ)	Prod. on *F* (f)	Loss Aversion (λ)	*B*'s Military Stock ($\bar{M}_B$)	Reference Level of Control ($\tilde{Q}$)	Optimal Civilian Killing (V*)	Optimal Fighting (F*)	Optimal Identity (I*)	Optimal Cons. (C*)	Optimal Control (Q_A^*)	Utility (U*)
1	**5**	**1000**	**5**	**5**	**0.25**	**0.5**	**3**	**10**	**900**	**7.4**	**44.1**	**44.1**	**104.4**	**574.6**	**45.7**
2	**6**	1000	5	5	0.25	0.5	3	10	900	**5.7**	44.2	44.2	104.7	572.1	39.3
3	**7**	1000	5	5	0.25	0.5	3	10	900	**4.6**	44.3	44.3	104.9	570.0	34.3
4	**8**	1000	5	5	0.25	0.5	3	10	900	**3.8**	44.4	44.4	105.1	568.4	30.2
5	5	**1250**	5	5	0.25	0.5	3	10	900	**9.0**	50.0	50.0	141.0	574.6	272.2
6	5	**1500**	5	5	0.25	0.5	3	10	900	**10.5**	55.2	55.2	179.2	610.5	470.2
7	5	1000	**10**	5	0.25	0.5	3	10	900	**7.4**	15.1	60.5	101.7	536.7	-81.2
8	5	1000	5	**10**	0.25	0.5	3	10	900	**10.0**	53.5	53.5	41.5	605.6	-238.8
9	5	1000	5	5	**0.3**	0.5	3	10	900	**11.6**	43.3	43.3	101.8	585.2	64.3
10	5	1000	5	5	**0.4**	0.5	3	10	900	**38.5**	38.0	38.0	85.6	644.5	158.7
11	5	1000	5	5	**0.430**	0.5	3	10	900	**76.2**	29.9	29.9	64.0	715.4	246.2
12	5	1000	5	5	**0.438**	0.5	3	10	900	**122.8**	19.6	19.6	38.1	794.0	299.0
13	5	1000	5	5	0.25	**0.4**	3	10	900	**7.6**	22.3	64.8	105.2	532.9	-75.3
14	5	1000	5	5	0.25	**0.3**	3	10	900	**7.7**	10.7	76.5	105.1	513.1	-135.5
15	5	1000	5	5	0.25	0.5	**4**	10	900	**9.5**	51.9	51.9	86.7	600.8	-265.6
16	5	1000	5	5	0.25	0.5	**5**	10	900	**11.3**	58.0	58.0	72.8	618.2	-555.6
17	5	1000	5	5	0.25	0.5	**6**	10	900	**12.8**	62.8	62.8	61.6	630.7	-830.8
18	5	1000	5	5	0.25	0.5	3	**11**	900	**6.4**	44.6	44.6	104.3	547.1	-37.6
19	5	1000	5	5	0.25	0.5	3	**12**	900	**5.6**	45.0	45.0	104.5	521.7	-112.8
20	5	1000	5	5	0.25	0.5	3	10	**1000**	**7.4**	44.1	44.1	104.4	574.6	-254.3

Notes:

1. Case 1 is the "baseline simulation"
2. All simulations assume:
   A=100 and α=0.5 (equation 1); Q=1000 (equation 2); ψ=1, θ=1, ι=0.5, and ω=2 (equation 3); $\bar{M}_B$=10, Φ=1 (equation 4); P_I=5 (equation 5)

Table 2: Simulations in Which Optimal Civilian Killing Is Essentially Zero (Assuming Ratio-form Contest Success Function)

Case	Price of *V* (P_V)	Resources (R_A)	Price of *F* (P_f)	Price of *C* (P_c)	Prod. on *V* (υ)	Prod. on *F* (*f*)	*B*'s Military Stock ($\bar{M}_B$)	Reference Level of Control ($\tilde{Q}$)	Loss Aversion (λ)	Optimal Civilian Killing (*V**)	Optimal Fighting (*F**)	Optimal Identity (*I**)	Optimal Cons. (*C**)	Optimal Control (Q_A^*)	Utility (*U**)
1	**5**	**1000**	**5**	**5**	**0.25**	**0.5**	**10**	**900**	**3**	**7.4**	**44.1**	**44.1**	**104.4**	**574.6**	**45.7**
21	**100**	1000	5	5	0.25	0.5	10	900	3	**0.1**	45.2	45.2	107.2	572.1	39.3
22	5	**100**	5	5	0.25	0.5	10	900	3	**0.5**	8.2	8.2	3.0	290.0	-1656.2
23	5	1000	**0.1**	5	0.25	0.5	10	900	3	**3.8**	2397.9	1.0	147.3	847.9	1057.2
24	5	1000	5	**0.1**	0.25	0.5	10	900	3	**0.6**	9.1	9.1	9063.0	306.1	7738.3
25	5	1000	5	5	**0.01**	0.5	10	900	3	**0.2**	45.3	45.3	109.1	559.8	24.1
26	5	1000	5	5	0.25	**1.5**	10	900	3	**0.3**	25.5	0.0	174.2	932.0	1351.8
27	5	1000	5	5	0.25	0.5	**50**	900	3	**0.4**	28.0	28.0	143.6	148.5	-1056.1
28	5	1000	5	5	0.25	0.5	10	900	**1**	**2.1**	20.0	20.0	158.0	441.0	797.8
29^{μ}	5	1000	5	5	0.25	0.5	10	900	3	**0.0**	1.2	1.2	197.7	16.5	1280.7^{μ}

Notes:

1. Case 1 is the "baseline simulation"
2. All simulations assume:
   A=100 and α=0.5 (equation 1); Q=1000 (equation 2); ψ=1, θ=1, ι=0.5, and ω=2 (equation 3); $\bar{M}_B$=10, Φ=1 (equation 4); P_I=5 (equation 5).
3. Simulation numbers in the first column continue from Table 1.
4. $^{\mu}$ Simulation 29 assumes diminishing marginal utility at degree μ=0.55 to the loss aversion portion of the utility function as follows:
   $U(C,Q) = AC^{\alpha} - \lambda\left[(-1)\left(Q_A - \tilde{Q}\right)\right]^{\mu}$

Table A1: Simulations of Architect's Demand for Atrocity (Assuming Logistic Contest Success Function)

Case	Price of *V* (P_V)	Resources (R_A)	Price of *F* (P_f)	Price of *C* (P_c)	Prod. on *V* (υ)	Prod. on *F* (f)	*B*'s Military Stock ($\bar{M}_B$)	Reference Level of Control ($\tilde{Q}$)	Loss Aversion (λ)	Optimal Civilian Killing (V^*)	Optimal Fighting (F^*)	Optimal Identity (I^*)	Optimal Cons. (C^*)	Optimal Control (Q_A^*)	Utility (U^*)
1A	**5**	**500**	**5**	**5**	**0.25**	**0.5**	**10**	**900**	**3**	**4.6**	**39.4**	**39.4**	**16.5**	**883.4**	**763.0**
2A	**6**	500	5	5	0.25	0.5	10	900	3	**3.6**	39.8	39.8	16.0	880.7	742.8
3A	**7**	500	5	5	0.25	0.5	10	900	3	**3.0**	40.1	40.1	15.6	878.5	726.3
4A	**8**	500	5	5	0.25	0.5	10	900	3	**2.5**	40.3	40.3	15.3	876.6	712.5
5A	5	**1500**	5	5	0.25	0.5	10	900	3	**4.7**	40.7	40.7	213.9	903.4	2928.1
6A	5	**2500**	5	5	0.25	0.5	10	900	3	**4.9**	42.9	42.9	409.2	930.4	4076.3
7A	5	500	**10**	5	0.25	0.5	10	900	3	**6.0**	14.6	58.2	6.7	732.3	15.8
8A	5	500	5	**7**	0.25	0.5	10	900	3	**4.7**	40.3	40.3	10.6	896.5	640.3
9A	5	500	5	5	**0.3**	0.5	10	900	3	**6.5**	38.0	38.0	17.5	889.4	804.1
10A	5	500	5	5	**0.35**	0.5	10	900	3	**9.1**	36.0	36.0	18.9	897.4	861.0
11A	5	500	5	5	**0.7**	0.5	10	900	3	**30.3**	4.0	4.0	61.8	946.5	1618.3
12A	5	500	5	5	**0.83**	0.5	10	900	3	**23.3**	1.1	1.1	74.6	975.6	1803.1
13A	5	500	5	5	0.25	**0.4**	10	900	3	**6.3**	22.1	64.0	7.6	737.7	64.3
14A	5	500	5	5	0.25	**0.3**	10	900	3	**7.1**	10.7	76.3	5.9	599.7	-415.6
15A	5	500	5	5	0.25	0.5	**11**	900	3	**4.9**	42.8	42.8	9.4	828.7	400.7
16A	5	500	5	5	0.25	0.5	**12**	900	3	**5.0**	45.1	45.1	4.8	715.8	463.0
17A	5	500	5	5	0.25	0.5	10	**1000**	3	**4.6**	39.4	39.4	16.5	883.4	-254.3
18A	5	500	5	5	0.25	0.5	10	900	**2.5**	**4.5**	38.5	38.5	18.4	866.6	775.3
19A	5	500	5	5	0.25	0.5	10	900	**2**	**4.4**	37.3	37.3	20.9	841.3	797.8
20A	5	500	5	5	0.25	0.5	10	900	**1.5**	**4.3**	35.6	35.6	24.5	798.5	836.8

Notes:

1. Case 1A is the "base simulation" for the logistic CSF.
2. All simulations assume:
   A=200 and α=0.5 (equation 1); Q=1000 (equation 2); ψ=1, θ=1, ι=0.5, and ω=2 (equation 3); Φ=1 (equation 4); P_I=5 (equation 5)
3. The trend in row 8A compared to row 1A is not general. If P_c rises enough, optimal *V*, *F*, and *I* will each begin to decline with higher P_c.

Table A2: Simulations in Which Optimal Civilian Killing Is Essentially Zero (Assuming Logistic Contest Success Function)

Case	Price of *V* (P_V)	Resources (R_A)	Price of *F* (P_f)	Price of *C* (P_c)	Prod. on *V* (υ)	Prod. on *F* (*f*)	*B*'s Military Stock ($\bar{M}_B$)	Reference Level of Control ($\tilde{Q}$)	Loss Aversion (λ)	Optimal Civilian Killing (*V**)	Optimal Fighting (*F**)	Optimal Identity (*I**)	Optimal Cons. (*C**)	Optimal Control (Q_A^*)	Utility (*U**)
1A	**5**	**500**	**5**	**5**	**0.25**	**0.5**	**10**	**900**	**3**	**4.6**	**39.4**	**39.4**	**16.5**	**883.4**	**763.0**
21A	**100**	500	5	5	0.25	0.5	10	900	3	**0.1**	43.3	43.3	11.5	847.6	521.0
22A	5	**250**	5	5	0.25	0.5	10	900	3	**0.0**	0.0	0.0	50.0	0.0	-1285.8
23A	5	500	**0.1**	5	0.25	0.5	10	900	3	**0.1**	260.3	0.1	94.6	993.3	2038.6
24A	5	500	5	**0.5**	0.25	0.5	10	900	3	**0.0**	0.0	0.0	1000.0	0.0	3624.6
25A	5	500	5	5	**0.01**	0.5	10	900	3	**0.1**	42.1	42.1	15.7	875.5	720.2
26A	5	500	5	5	0.25	**1.1**	10	900	3	**0.1**	12.4	0.1	87.4	992.4	1961.8
27A	5	500	5	5	0.25	0.5	**0.1**	900	3	**1.0**	4.3	4.3	90.4	954.5	1956.3
28A	5	500	5	5	0.25	0.5	10	900	**1**	**4.1**	32.8	32.8	30.4	705.3	907.2
29A[μ]	5	500	5	5	0.25	0.5	10	900	3	**1.0**	4.0	4.0	91.0	0.9	1557.3 [μ]

Notes:

1. Case 1 is the "baseline simulation"
2. All simulations assume:
   A=100 and α=0.5 (equation 1); Q=1000 (equation 2); ψ=1, θ=1, ι=0.5, and ω=2 (equation 3); Φ=1 (equation 4); P_I=5 (equation 5).
3. Simulation numbers in the first column continue from Table A1.
4. [μ] Simulation 29A assumes diminishing marginal utility at degree μ=0.7 to the loss aversion portion of the utility function as follows:
   $U(C,Q) = \mathrm{A}C^{\alpha} - \lambda\left[(-1)\left(Q_A - \tilde{Q}\right)\right]^{\mu}$