Hauser Globalization Colloquium Fall 2009:
Interdisciplinary Approaches to International Law

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SUPPLEMENTAL READING

Chapter 3'

Modeling Minutia

This chapter presents the formal details of the mathematical model of the laws of war discussed in Chapter 3. It is primarily intended for those interested in those details. Other readers may wish to skip ahead to Chapter 4 which presents the patterns of compliance with the laws of war. I present each of the three models separately and examine their equilibria. The first focuses on soldier-to-soldier interaction on the battlefield as matching model between the two infinite sets of soldiers. The second models military discipline within a state's military as a principal-agent model. The third model builds on [Smith, 1998 #530] 's model of war as a gambler's ruin problem where the parties can influence their chance of winning by having their soldiers commit violations. This state-to-state model represents a treaty as a preplay agreement to limit the level of violations that each commits. After presenting the three models separately, I examine their interaction. Certain equilibria of the individual games cannot be sustained when they are played in concert with the other games. The institution of the laws of war is then a set of equilibria of the three games together which support one another. Multiple sets of complementary equilibria are possible, making public agreement on which set to be played important. I also examine selection among these equilibria and discuss issues in the design of the institution.

The Three Models

There are four actors, or set of actors in the three models. I refer to the two countries with the colorful names of **A** and **B**. Each country has a government, labeled *A* or *B*, and an army which is a very large set of individuals, $\{a_i\}$ or $\{b_j\}$, respectively, with equal numbers of soldiers in each army. Individual soldiers have type t_i drawn from a uniform distribution on $[0,1]$. The number of soldiers in each army is assumed to be very large so that any soldier can be treated as a draw from this distribution without worrying about whether certain types are removed from the distribution over rounds of the games. All three models are kept simple to emphasize the interaction of their equilibria. For each, I describe the game and then present the equilibria of the game in isolation.

On the Battlefield

The soldiers of the two armies meet on the battlefield. The combat environment is represented by randomly matched all soldiers into pairs with one soldier from each side. They then play the simultaneous game in Figure 3'.1 below. Each soldier chooses between *H*–honoring the existing treaty standard, and *V*–violating that standard by committing an atrocity. The game has two parameters, T with $0 < T < 1$ for the temptation to commit violations and $V < 0$ for the vulnerability to violations. These parameters vary with the issue-area the game covers. T would be higher for issues where an individual soldier could benefit from a violations, such as looting on the issues of treatment of civilians. I restrict T to be less than 1 so that some a_i,b_j prefer not committing violations. V would be greater in magnitude for issues where the soldier suffers greater consequences as a victim of a violation, such as on treatment of prisoners of war or enemy wounded. Each soldier's type t_i gives his "personal cost" for committing opportunistic violations, with higher values denoting less willingness to violate.

Figure 1
Battlefield Violation Game

		b_j Honor	b_j Violate
a_i	Honor	(0,0)	(V, T-t_j)
a_i	Violate	(T-t_i ,V)	(-1,-1)

This game has multiple equilibria, with the character of the equilibria depending on whether $T + V \geq -1$. In each symmetric case below, b_j plays the same strategy based on its type that a_i, so I omit their strategy to save duplication. For the asymmetric equilibrium, I list only one of each pair; the other can be found by reversing a_i and b_j.

Equilibria: Let $t\text{-}_{crit} = 1 + ½(T+V) - ½((T+V)^2+4V+4)^{½}$ and $t+_{crit} = 1 + ½(T+V) + ½((T+V)^2+4V+4)^{½}$.

Case 1: If $V > -1$, then

a) there is a symmetric equilibrium: a_i plays Honor when $t_i > t\text{-}_{crit}$, Violate otherwise.

b) If $(1 - T)(V + 1) \geq T^2$, there are two asymmetric equilibria: a_i plays Honor when $t_i > T$, Violate otherwise; b_j plays Honor for all types and reversing *a* and *b*.

Case 2: If $V \leq -1$ and $(T+V)^2+4V+4 > 0$, then there are three symmetric equilibria (ranked from the one with the lowest frequency of violations to the highest):

a) a_i plays Honor when $t_i > t\text{-}_{crit}$, Violate otherwise;

b) a_i plays Honor when $t_i > t\text{+}_{crit}$, Violate otherwise; and

c) all a_l play Violate.

Case 3: If $(T+V)^2+4V+4 < 0$ (this implies $V \leq -1$), then all a_i,b_j play Violate.

<u>Proof</u>: When $V \leq -1$, Violate is a best reply to itself for all types. Honor is not a best reply to itself for types $t < T$. To find mixed strategies across types, let a,b be cutpoint of types for each side respectively playing Honor for $t > a$ and Violate otherwise. Setting expected utility of both strategies equal to find the cutpoints, we have the following pair of equations:

$$b(T + V + 1) = T - a(1 - b)$$

$$a(T + V + 1) = T - b(1 - a)$$

Symmetric equilibria are found by setting $a = b$ and solving the resulting quadratic equation to get $t\text{-}_{crit}$ and $t\text{+}_{crit}$. $(T+V)^2+4V+4$ is the discriminant of this quadratic equation, so it has real roots when the discriminant is positive in Cases 1 and 2. Subtracting the second equation from the first leads to

$$(b - a)(T + V) = 0$$

which implies that asymmetric equilibria where $a \neq b$ are not possible except when $T = -V$ (which I do not consider here).

When $V > -1$, Violate is no longer a best reply to itself. Honor dominates Violate for all $a_i,b_j > T$. This leads to the symmetric equilibrium for $t\text{-}_{crit}$; $t\text{+}_{crit} > 1$. The asymmtric equilibrium arises when $t = 0$ for one player prefers Honor to Violate given that types of the other player with $t < T$ will Violate. The condition of the asymmetric equilibrium matches the indifference condition between Honor and Violate for $t = 0$.

The strategic logic of the cases is simple. The first case has dynamics similar to Chicken in the sense that being a victim is preferable to both playing Violate. The symmetric equilibrium has low levels of violations, although violations by those with low costs for committing violations (low types) cannot be deterred. The asymmetric equilibrium comes from the Chicken dynamics. When one side will always play Honor, low types of the other side will commit violations. These violations are common enough to deter even the lowest type of the first side from committing violations. The use of chemical weapons could be such a case where from the individual soldiers' view, it is preferable to run a small risk of suffering a chemical attack to the certainty of a battlefield where both sides use chemical weapons regularly. The second and third cases have prisoners' dilemma payoffs for low types ($t < T$), those who are willing to commit violations. They always prefer Violate. The risk of facing such a type leads some types to play Violate to avoid the worse payoff of being a victim (you play Honor, opponent plays Violate, payoff T) even though they prefer the outcome where both play Honor (payoff 0) to their own unilateral violation (payoff $T - t_i < 0$). Case 3 is the extreme case where the risk that the other side will violate is so high that all types play Violate to protect themselves; V is noticeably less than -1 for the condition of this case to hold. The consequences of being a victim are large enough that everyone commits violations to protect themselves from being a victim.

Strategic expectations, not reciprocity, drive the behavior in this game. The multiple equilibria in Case 2 all have different strategic expectations from the common conjectures underlying them. In the first subcase, violations are rare, leading to restraint by those who do not want to commit violations, In the second subcase, the expectations of violations from the other side are higher, leading to violations for protection from being a victim. The third subcase is the complete breakdown with anticipations that violations will always be committed. Similarly, the common conjecture drives whether the symmetric or asymmetric equilibrium is played under Case1, along with which side will not commit violations under the asymmetric equilibrium. Although the game is considered to be repeated, only the anticipation of what the other side will do in this round affects the players' choices. No one is ever suffers retaliation in a future round for violations in this round.

Military Discipline

Each government and its soldiers have a principal-agent relationship, where soldiers are agents of the state. For ease, we will assume the state is A. The government A would like its soldiers $\{a_i\}$ to comply by playing Honor rather than Violate. Many but not all a_i would play Honor left to their own devices; they have the same payoff structure as in the Battlefield game if the opponent plays Honor. A can monitor the soldiers, choosing a probability of detection of those who Violate, denoted by p with $0 \leq p \leq 1$. Monitoring is costly for A in two ways. One, creating the capability for monitoring costs the probability of successful detection, pD, where D represents the cost of detecting violations on that given issue. D is assumed to average 1 across issues. Second, A suffers losses for every soldier a_i caught committing violations, with the total loss equal to the fraction of soldiers caught committing violations. You no longer have an army if you arrest them all for war crimes. For convenience, I assume the punishment of any soldier a_i detected committing violations is -1.

The time line of the monitoring and discipline game is as follows:

1. A chooses p and announces it publicly.

2. All $\{a_i\}$ choose Honor or Violate.

3. Nature determines whether each a_i who played Violate is detected with probability p of detection. Payoffs are received as follows:

a_i played Honor: 0

a_i played Violate and not detected: $T - t_i$

a_i played Violate and detected: $T - t_i - 1$

A: $\#(a_i \textit{ played Honor})/\#(a_i) - \#(a_i \textit{ played Violate and detected}) - pD$

The equilibrium of the monitoring game is straightforward. It depends on the cost of monitoring as follows:

Equilibrium: A: Choose $p = T$ if $D < 1$ and $p = 0$ otherwise

a_i: Violate if $t_i < T - p$.

Proof: Proceed by backward induction. a_i plays Violate if $T - t_i - p(1) > 0$. Given a_i's best reply correspondence, A's expected utility for setting detection at p is as follows:

$$(1 - T + p) - p(T - p) - pD \text{ if } p \leq T, \text{ and } 1 - pD \text{ if } p > T$$

Although the first order condition generally locates an interior point, the second derivative with respect to p is positive, meaning that point is a minimum. The maximum then is one of the endpoints, either $p = 0$ or T. Substitution into the expected utility leads to A's optimal monitoring strategy.

Simply, *A* engages in no monitoring when monitoring is more costly than average because the dual cost of setting up the monitoring and of catching some of its soldiers in violations exceeds the benefit of deterring violations. When monitoring is less costly than average, this calculation reverses, and *A* engages in enough monitoring to deter all violations.

State-to-State Deterrence

The war between *A* and *B* is represented by a model in the spirit of Smith (1998). I present the full model in a series of steps, beginning with the basic model of war, adding decisions to commit atrocities in the effort to prevail, and end by examining prewar agreements to limit such violations. The sides fight a series of battles over an ordered set of fixed points in discrete time. The endpoints of the set represent total victory for one side or the other. The initial state of the war is one of these points. Each battle moves the state one position closer to the victory outcome for the winning side. The winner of each battle is determined by a given and known probability q with $½ \leq q < 1$ (I assume that *A* is stronger than *B* and so more likely to win any individual battle for convenience). There are then $N+1$ states to the game, the set $\{0,1,...,N\}$, where state N represents complete victory for *A* and 0 complete victory for *B* and initial state k. Refer to any state as S_i. In each round, both players choose simultaneously whether to continue fighting or quit. Quitting gives the entire stakes to the other side, which both sides value as 1. Each side pays costs of $c_A, c_B > 0$ for each round. If side i quits in round $N+1$, its payoff is then $-Nc_i$ and the other side's payoff is $1 - Nc_j$. The costs per round are assumed to be small enough that both sides are willing to continue to fight if they could win in the next round; $c_A < q$ and $c_B < 1 - q$.

I focus on the monotone equilibria of the game ([Smith, 1998 #530]). The players have cutpoint strategies in these equilibria in which they play Continue for all states on one side of the cutpoint and Quit for those on the other.

Equilibrium: Let

$$F_A(k) = \left(k + \sum_{j=1}^{k}\sum_{i=1}^{j}\left(2k - (2i-1)\right)\alpha^{i}\right)c_A \ and$$
$$F_B(k) = \left(k + \sum_{j=1}^{k}\sum_{i=1}^{j}\left(2k - (2i-1)\right)\alpha^{-i}\right)c_B$$

for non-negative integer k and $\alpha = (1-q)/q$. Define K_A as smallest k such that $F_A(k) \geq 1$ and K_B parallel for F_B. The following are monotone equilibria of the game:

Case 1: $K_A > K_B$. A plays Continue for all $k > 0$. B plays Continue for $k < K_B$, Quit otherwise.

Case 2: $K_A < K_B$. A plays Continue for all $k > N - K_A$, Quit otherwise. B plays Continue for all $k < N$.

Case 3: $K_A = K_B$. For M such that $K_A \leq M \leq N$, A plays Continue for all $k > M - K_A$, Quit otherwise. B plays Continue for $k < M$, Quit otherwise.

Case 3a: If $K_A \geq N$ and $K_B \geq N$, A plays Continue for all $k > 0$, B plays Continue for all $k < N$.

Proof: First, show that both players play monotone cutpoint strategies defined by a state where the player plays Continue if the state is higher (for A, lesser for B) than that and Quit otherwise. Let $V_A(k)$ be A's continuation value for playing the game from state k and $V_A(\sigma,k)$ be A's continuation value for playing σ from state k (parallel notation will be used for B). Let k be the lowest state where B always quits or N if no such state exists. $V_A(k) =$

1 by definition. $V_A(Continue,k\text{-}1) \geq q - c_A > 0$, so A must play Continue in equilibrium in state $k\text{-}1$. There is then a range of states $\{l,l+1,...N\}$ where A plays Continue, $V_A(l) > 0$, and $l \leq k\text{-}1$. Let $m < l$ be state where A plays Continue with positive probability. B plays Continue with positive probability at $k\text{-}1$, so $V_B(k\text{-}1) \geq 0$.

Note that if a player plays Quit at two states, l and m, and the other player never plays Quit for any state $l \leq k \leq m$, $V(k) = 0$ and the first player must play Quit for all such k. From any such state k, all histories of play lead to the first player quitting before the other because either l or m are reached before any state where the other player plays Quit. The value and optimal play of Quit at all these states immediately follows.

Furthermore, there cannot be ranges of states where both players mix between Continue and Quit. If there were, then $V_A(s) = 0 = V_B(s)$ for all such states s. Let k be the least such state where B plays a mixed strategy. At least one player plays Continue with probability 1 in state $k\text{-}1$ because both playing Quit is not a mutual best reply. If only one player plays Continue at $k\text{-}1$ (say B for convenience), then $V_A(k\text{-}1) = 0$. But then $V_A(k,Continue) = (1\text{-}q)V_A(k\text{-}1) + qV_A(k+1) - c_A = (1\text{-}q)*0 + q*0 - c_A < 0$, and Continue is not a best reply for A at state k. This contradicts that A plays a mixed strategy at k. If both players play Continue at $k\text{-}1$, then both players play Quit with positive probability for some state less than $k\text{-}1$. Otherwise, $V(k\text{-}1,Continue) < 0$. The states lower than $k\text{-}1$ where each player quits cannot be the same because Quit is not a best reply to itself nor may they be mixed for both because k is the lowest state where both players mix. For the player who quits at the higher state of these two, $V(i) = 0$ for all states between k and this quit state, implying that $V(i,Continue) < 0$ for these states and Quit is best reply. This contradicts this player playing Continue with positive probability at $k\text{-}1$.

In a monotonic equilibrium, each player's value increases or decreases across the set of states with $V(s) = 0$ for any state where the player quits and $V(s) = 1$ for any state where the other player quits. Because $V_A(N) = 1$, $V_A(0) = 0$, $V_B(0) = 1$, and $V_B(N) = 0$, V_A is increasing and V_B decreasing. Each player's value function satisfies the following nonhomogenous difference equation (I drop the subscript denoting *A* or *B* because the equation holds for both):

$$V(s+1) - V(s) = \alpha(V(s) - v(s-1)) + (1+\alpha)c$$

where $\alpha = (1 - p)/p$. The solution to the nonhomogenous equation is

$$V(k) = C\left(k + \sum_{j=1}^{k}\sum_{i=1}^{j}(2k - (2i-1))\alpha^{i}\right)c + (1-C)\left(n - k + \sum_{j=1}^{n-k}\sum_{i=1}^{j}(2(n-k) - (2i-1))\alpha^{-i}\right)c$$

The corresponding homogenous difference equation is

$$V(s+1) - V(s) = \alpha(V(s) - v(s-1))$$

with a family of solutions: $A + B\alpha^{k}$. Any sum of these two solutions for values of *A,B,C* are solutions of the nonhomogenous difference equation ([Elaydi, 2005 #531], Theorem 2.30, 84). The first part of $V(k)$ is increasing in *k*, while the second part is decreasing. Calculations shows that the first part of $V(k) = F_A(k)$ gives *A*'s value for state $m+k$ when *A* quits at state *m*; the second part then gives *B*'s value for state *k* if *B* quits at state *n* and equals $F_B(k)$. (These functions can be found by solving the nonhomogenous difference equation recursively from $F_A(0) = 0$). K_A, K_B give the states where each player's value for playing Continue exceeds *1*, and so specifies the number of states which each player has positive value for playing Continue from the state where the other player Quits. For instance, if *A* Quits at state *k*, *B*'s best reply plays Quit for state $k + K_B$ and Continue for all states less than $k + K_B$. When $K_A = K_B$, any pair of states *k,l* form an equilibrium of

Quit points when $|k - l| = K_A$. When $K_A > K_B$, the only mutual best replies are A quitting at 0 and B quitting at K_B. When $K_A < K_B$, the only mutual best replies are A quitting at $N - K_A$ and B quitting at N.

Note: When $K_A = K_B = K$ and $N \geq 3K$, there are equilibria where A and B alternate ranges of states where they quit. For example, A plays Continue for states $(1,2K-1)$ and $(2K+1,N)$, Quit for $2K$ and B plays Continue for $(0,K-1)$ and $(K+1,N-1)$ and Quit for K can form an equilibrium. I do not consider equilibria like this because they are equivalent on the equilibrium path to an equilibrium of given in the proposition depending on the initial state of the game or produce counterintuitive behavior. An example of the latter occurs in the range of $(K,2K)$ in the equilibrium above where both players gain by losing battles rather than winning them.

Note: The value functions for both players in an equilibrium where A quits for $s \leq m$ and B quits for $s \geq m + K$ can be found from the full set of solutions of the inhomogenous difference equation by setting $C = 1$ for A and $C = 0$ for B and then solving for A,B given the boundary conditions that $V_A(m) = 0$ and $V_A(m + K) = 1$ or $V_B(m) = 1$ and $V_B(m + K) = 0$. Solving, we have the following value function for V_A (using definition of F_A in statement of equilibrium):

$$V_A(k) = \begin{cases} 0 & if\ k \leq m \\ F_A(k-m) + \left(\dfrac{1-F_A(K)}{1+\alpha^K}\right)(1+\alpha^{k-m}) & if\ m < k < m+K \\ 1 & if\ k \geq m+K \end{cases}$$

I add the choice of committing violations to each round of this game. In addition to the choice whether to Continue or Quit, both players decide what proportion of their soldiers they wish to have commit violations. These violations affect both the probability of winning the current battle and the costs of fighting for both sides. The transition probability from state to state depends on how many of the country's soldiers Violate rather than Honor the treaty appropriate standard: $p(S_{i+1}) = q + r(\#a_i\ violate/\#a_i) - s(\#b_j\ violate/\#b_j)$ with $p(S_{i-1}) = 1 - p(S_{i+1})$ and $r,s > 0$. Both players' costs of war are increased both by the number of soldiers who commit violations on both side; specifically, *A*'s costs equal $c_A + d_A(\#a_i\ violate/\#a_i) + w_A(\#b_i\ violate/\#b_i)$ [*B*'s costs are $c_B + d_B(\#b_i\ violate/\#b_i) + w_B(\#a_i\ violate/\#a_i)$] with $d_A, d_B, w_A, w_B > 0$. Each player's strategy maps the state into how many soldiers it will order to Violate in the current round and whether the player Quits or Continues. Refer to the fraction of soldiers that *A* orders to violate to be *x*, with *y* being the same fraction for *B*

Lemma: In equilibrium, *A* plays $x = \{0,1\}$ and has a state L_A such that *A* plays $x = 0$ for all states $k < L_A$ and $x = 1$ for all $k \geq L_A$. (The parallel result holds for *B*.)

Proof: *A*'s value from state *k* is

$$V_A(k) = (q + rx - sy)V_A(k+1) + (1 - q - rx + sy)V_A(k-1) - c_A - d_A x - w_A y$$

The first order condition for maximizing this value is positive if

$$V_A(k+1) - V_A(k-1) > d/r$$

and negative if the inequality is reversed. Optimal levels of *x* are then the extreme values of the range, *0,1*, depending on the direction of the inequality above.

$$V_A(k+1) - V_A(k-1) = \left(2 + \alpha^{k+1} + 4\alpha^k + 4\sum_{i=1}^{k-1}(k+2-i)\alpha^i\right)c_A + \left(\frac{1 - F_A(K)}{1 + \alpha^K}\right)\left(\alpha^{k+1} - \alpha^{k-1}\right)$$

which is increasing in k. This implies that if $x = 1$ is optimal for some state k, it is for all states greater than k.

The first order condition above leads directly to comparative statics for the states where a side will commit violations. As in the lemma above, the closer a side is to winning, the more likely the inequality will be satisfied. This is because the differences in the value function increase as a side gets closer to victory. Second, violations become more attractive the larger the battlefield advantage produced by them (r). Third, the lower the cost a side suffers for committing violations, the more attractive do so is.

The state-to-state game of compliance reduces to a two-by-two game because each players plays 0 or 1 in each round. Call these moves *Not Violate (NV)* or *Violate (V)* for convenience. Refer to each player's value for each of the four outcomes as $V_A(s_A,s_B,k)$ or $V_B(s_A,s_B,k)$ where s_A,s_B are the strategies and k is the current state. Both players prefer outcomes where the other does not violate, $V_A(s_A,NV,k) > V_A(s_A,V,k)$ for A for instance, because their costs are higher and probability of winning each battle lower when the other violates. The other comparisons of outcomes depend on the exact values of the parameters. $V_B(s_A,s_B,k)$ is increasing in the probability A wins the next battle, $q + rx - sy$, and decreasing in A's costs, c_A, directly from the generating equation of V_A.

Each player's decision whether to violate or not does not depend on the other player from the lemma above. There are then three possible cases in the two-by-two game:

1. Both players prefer to play Not Violate.
2. One player prefers to play Violate while the other prefers to play Not Violate.

3. Both players prefer to play Violate.

The first case covers issues where neither player would commit violations on their own. The second case is asymmetric where one can benefit from violations while the other does not. The third case covers those issues where both players can benefit from violations. This case has the familiar Prisoners' Dilemma dynamics when $V(NV,NV,k) > V(V,V,k)$. It need not have such dynamics when this inequality is reversed for one of the players. It cannot be the case that both players have $V(NV,NV,k) < V(V,V,k)$. This preference is possible only when a player's probability of winning is higher when they both play Violate than when they both play Not Violate because costs increase. If one player's probability of winning a battle increases, the other's must decrease and then the latter cannot prefer $V(V,V,k)$ to $V(NV,NV,k)$. Finally, each of these two-by-two games is defined for each state k where both players play Continue. It need not be the case that the same preference order, and hence the same game, holds for all such states. The lemma above shows that a player's preference between Not Violate and Violate can change as it approaches victory (as the current state approaches the state where the other player will Quit).

When can prewar agreements to play Not Violate be enforced through reciprocity? The first case requires no such agreement; both players comply out of their own interest. The asymmetric cases of the third type cannot be enforced through reciprocity. The player that prefers $V(NV,NV,k)$ to $V(V,V,k)$ lacks a reciprocal threat to play from the latter outcome. Switching its strategy from Violate to Not Violate makes the other player better off and the other player prefers $V(V,V,k)$ to $V(NV,NV,k)$. In the second case, this player has the reciprocal threat to play Violate, and so might be able to use that threat to induce the other player to play Not Violate. This player, however, lacks the incentive to play Violate in the round following the other player playing Violate because it prefers Not Violate no matter what the other player does. The threat would not be carried out in equilibrium and so will not deter the play of Violate by the other. This leaves only the set of the third case where the game is Prisoners' Dilemma. The hardest case for reciprocity occurs when a player is one state away from winning. Its benefit from violating is two-fold; it increases the chance of winning and so avoiding retaliation, and the difference between winning and losing the battle is larger than at any other point. Calculating the value for violating and not for *A* at state *K-1* (one winning battle away from winning the war) and reducing, we have the following condition for when *A* will honor an agreement not to violate:

$$(1 - q)[V_A(NV,NV,K\text{-}2) - V_A(V,V,K\text{-}2)] \geq r_A[1 - V_A(V,V,K\text{-}2)] - d_A$$

The right-hand side is positive because the first-order condition for violating is satisfied. If the above condition holds, the threat of a response in kind for one round is sufficient to deter *A* from playing Violate from any state.

The comparative statics of this inequality are follow the first-order condition. Higher costs for committing violations (*d*, remember that this is the cost the violating side pays for its own violations) and less strategic benefit (*r*, the increased chance of winning a battle from violations) make honoring the agreement more likely by reducing the right-hand side. The relative strength of the parties enters into the left-hand side in two ways. It changes the probability that the side in question will lose the current battle and so face the reciprocal sanction. This means that the condition is more likely to bind the weaker side than the stronger, and the effect increases with the underlying chance that the stronger side wins a battle (i.e. no violations by either side). The stronger side then is more likely to break such an agreement, all else equal.

The results above rely solely on one-round reciprocal punishments for enforcement.

Agreements for this form of enforcement could be ad hoc, through wartime negotiations. Because they hold only when both sides share an interest in limiting the costs of war, they are weaker than the treaties of international humanitarian law. Later, I discuss how universal treaties could be modeled as prewar agreements which trigger audience costs as an additional mechanism of enforcement. Before doing so, we consider combinations of the equilibria of the three games to show their interactions.

Violations and Compliance across the Three Models

Each of the three models captures a different portion of the strategic problems posed by the limitation of violence during wartime. How could do the equilibria of the separate models depend upon one another when the three games are linked?

Chapter 4'

Statistical Gore

Chapter 4 presented the patterns of compliance graphically and in simple tables. This companion chapter provides the details of the statistical analysis for readers interested in seeing "what is going on underneath the hood" of these results. I discuss issues of research design, the coding rules for the data, present the tables of the estimated coefficients, and further tests of the results reported in the prior companion chapter. I understand that some readers will not be interested in the material presented here and so may wish to skip ahead to Chapter 5 on the detailed analysis of prisoners of war.

I have broken this chapter into sections to allow the reader to move directly to particular topics of interest. These sections match the titles I used for reference in the preceding chapter. The order of the section generally matches the order of that chapter, although this chapter also includes analyses, such as that of declarations of war, that were not discussed in the prior companion chapter. The presentation here follows the standards of statistically oriented political science, as it is written for that audience.

This chapter presents the central results of my statistical work on the dataset, the statistical work underlying the graphics of the previous companion chapter. In doing that work, I explored many other possible specifications of the statistical models. Space, and the interest of most readers, preclude me from presenting all these combinations in these pages. Dina Zinnes once said that she figured that for every regression published in an article, 99 others went into the trash can. I do not think my ratio of specifications tried and discarded to those reported is quite that high, but my statistical trash can is hardly empty. In the spirit of allowing the interested reader to rummage through my statistical trash can, I have created a website, http://sitemaker.umich.edu/jdmorrow/lawsofwar, that contains a wide range of supplementary analyses to those reported here. I refer to some of these estimations in the text and footnotes. This website also contains the original data set as a spreadsheet, the data set including all the variables used here, and documentation of both to enable those who would like to conduct their own analyses with this data. John Ferejohn once remarked that "every scientist knows that the things that keeps you honest is that there is a graduate student out there with your name on it." These materials are now available for all, named and unnamed, even tenured professors, who might wish to labor in the muddy fields of data analysis.

The Data Collection

I have already described the data collection on compliance; here I address issues of the quality of that data and further details of the collection. In this section, I again use "we" to refer to the coding efforts to recognize Hyeran Jo's participation in the coding.

Clarifications of What Acts are Violations

When the higher military and civilian authority of a warring party adopts a policy not to violate an aspect of laws of war, that case is judged to have no violations unless historical sources report violations by individual combatants. Examples include Austria-Hungary explicitly refusing to attack hospital ships in the World War I ({Halpern, 1987 #99}, 319-20) and Saudis not using the few planes they had in Saudi-Yemeni war of 1934 ({Kostiner, 1993 #280}, 170). A contrary case is the destruction of Iraqi infrastructure by the United States during the Gulf War even though the United States adopted the Joint No-Fire Target List ({Lewis, 2003 #467}, 487).

Inadvertent violations are recorded as violations. For example, we code the destruction of the

National Museum in Budapest by the Soviet military during the Russo-Hungarian War of 1956, even though the Soviets did not intend to destroy it ({Mikes, 1957 #249}). We do so because the laws of war create obligations for individual soldiers against committing violations and for states to take steps to reduce inadvertent violations by their military forces.

Some violations could be classified in more than one issue area, raising the possibility of double coding. We explain what these incidents are and how we handled them in the following section on specific issues in the coding.

Coding Decisions for Specific Issue Areas

We report coding rules and judgments specific to a particular issue area and address special and difficult coding issues and cases. We also present some interesting cases to illustrate coding decisions

Aerial Bombardment

The coding rules for aerial bombardment are based on draft treaties that sought to address the bombing of nonmilitary or civilian areas. Legal clarity of violation is 3 by default because of the lack of any ratified treaty on aerial bombing. When it is unclear whether the town was defended at the time of violation or when the civilian casualties are not specifically reported with the bombing of civilian areas, clarity is rated as 2. When the air force of a belligerent is destroyed in the initial phase of war, no violation is recorded unless some bombing cases are reported. If a warring party has no or nominal air force, not applicable/available codes (-9) are assigned.

Aerial bombing of civilian areas are prohibited under treaties pursuant to aerial bombardment as well as those that address treatment of civilians. We code the aerial bombing of civilian areas under aerial bombardment because one, the primary purpose of the draft treaties addressing aerial bombardment is to distinguish civilian areas from military installations, and two, there are many violations against civilians other than aerial bombardment. Methods of warfare distinguish the violation in the area of aerial bombardment from that of civilian treatment. Aerial bombardment includes missiles and rockets if fired from a great distance so they act like bombers rather than artillery. Artillery attacks are coded under the treatment of civilians. Syria's conduct during the Six Day War illustrates this. Syria bombed Israeli civilians from the air on the first day; from the second day on, Syrian artillery barraged them ({Barker, 1980 #292}), which is coded under treatment of civilians.

Armistice/Ceasefire

Armistice violations are of two types: one, violation of official ceasefire before the agreed denouncement, and two, failure to respect white flags by individuals. We focus on the first and code the second only when sources report individual violations. Only armistice/ceasefire agreements *during* war are coded, following the general principle to code violations during war. Violations of pre-existed armistice line are not coded; for example, Israeli violation of 1947 armistice line in Sinai War of 1956 is not coded. These events at the origin of the war are addressed in the area of war declaration.

Chemical and Biological Weapons

The laws of war specify what is allowed and what is not as a method of war. For the practical matters with respect to CBW, it is less clear which items are prohibited since the list is not exhaustive. Two such weapons whose use is often alleged are dumdum bullets and tear gas. The use of dumdum bullets is a violation (e.g. Ethiopian use during the Italo-Ethiopian war of 1935-36), but many reports of dumdum bullet use are unsupported allegations, which are dismissed if not supported by concrete evidence of use. Use of tear gases is a minor violation with dispute over its legal status to reflect disagreement about whether such chemicals violate the relevant treaties.

Treatment of Civilians

Civilians suffer in almost every war. Civilians include all the protected persons of nonmilitary personnel in war zones; local residents, foreign nationals, diplomatic persons, religious missionaries, and international aid workers. We therefore consider civilians in combat zones who are not the nationals of warring parties. For instance, Italy and Turkey fought the Italo-Turkish War of 1911-12 in the Turkish Provinces in North Africa (modern Libya), and we code how Italy treated local Libyans as well as the Turks. How warring parties treat enemy civilians also matters. Although the WWII was not fought on the U.S. soil, treatment of enemy civilians resident in the U.S. by the government of the U.S. counts as violations. The internment of Japanese was therefore coded as a major violation.[1]

Protection of Cultural Property

We pay special attention to two aspects of the violation of cultural properties. First, We check whether the destroyed property fits the definition of 'cultural property' as defined in the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict. Second, We separate out looting of cultural property such as art that took place during wartime from those acts during postwar occupation. Similar to treatment of civilians, we code the destruction of cultural property in war zones where both warring parties fought even if the property was that of a third party state where the sides were fighting. The destruction of the Abbey at Monte Cassino in 1944 is coded as a violation by the Western Allies against Germany even though the cultural property was Italian because the Allies were fighting the Germans when they bombed the Abbey to rubble.

High Seas

The majority of violations of conducts on the high seas concerned illegal naval mining, naval bombardment of civilian areas, and attacks on merchant or hospital ships. We identify violations on international waters; we do not consider any engagement that occurred on rivers. As a consequence, many incidents occurred on Yangtze River ({Hsèu, 1972 #468}) in Sino-Japanese war of 1937-45 are excluded. For naval blockades, sources rarely provide sufficient evidences about the effectiveness of blockades for us to judge whether the blockade is effective, and hence legal or not.[2] We reflect this uncertainty in our codes for legal clarity of these cases.

Prisoners of War

Commonly reported violations of POWs are maltreatment or summary executions. In the absence of detailed information on treatment of POWs, we make some inferences. The death rate of POWs captured often provides general view of the treatment ({Morrow, 2001 #395}). We lack detailed accounts of Serbian treatment of Austria-Hungary POWs in the World War I but base our coding on the death rate of over 2/3rds ({Vance, 2000 #117}, {Fryer, 1997 #274}). We distinguish treatment of nationals, since the treatment of nationals differs even when held in the same camps.

The first dates for POW treatment are often difficult to track down. If the exact date of maltreatment is not available, we trace the date down to the most relevant incident, often the first date of the major battle. The first German violation of Italian POWs in World War I is dated to the Battle of Caporetto (October 24, 1917) where a large number of Italian soldiers were taken prisoner by German forces.

As noted before, POW repatriation is not an issue in the dataset because it is an incident after the war is over. The Soviet Union did not return Japanese POWs until 1956 after the Soviet Invasion of Manchuria in August 1945 ({Tucker, 2004 #469}, 307), but these reports of bad treatment of Japanese POWs and delayed repatriation by Russia after the Second World War were not coded.

Declaration of War

The laws of war do not provide clear guidance on practical problems that arise with respect to the declaration of war, so we had to render judgments in assigning codes. The foremost criterion concerns whether a state formally declares war before hostility in compliance with the 1907 Hague

Convention relative to the Opening of Hostilities. Violations of this convention involve judgments about the incidents that led to the first hostile military action: from ultimatum or diplomatic warning, expiration of ultimatum at the proposed deadline, and formal declaration of war prior to full scale war.

Taking into the chain of events in mind, we classified major and minor violations in the act of declaring war and determined the magnitude of violation, including its legality. Frequency gives size/number of attacks launched at the start of hostilities. Attack without any warning is magnitude 4 and clarity 4. Attack launched after ultimatum but much earlier than deadline is magnitude 3 and clarity 3. Failure to communicate an ultimatum in a timely fashion to the other belligerent falls into this case. The allied ultimatum that led to the interstate war portion of the Boxer Rebellion was delivered so late that the local Chinese forces could not consult central authorities before the deadline. The Relief Expedition is then responsible for the breakout of hostilities without adequate prior warning. Attack in response to ultimatum by the other side is magnitude 2 and clarity 2 as are attacks after the issuance of an ultimatum but before its expiry or formal declaration of war. An example of the latter was Germany's cross-border attacks into France before its declaration of war on August 3, 1914 but after the ultimatum to declare French intentions ({Gray, 1990 #135}, vol. 1, 14, 16, *New York Times*, August 2, 1914). Sides which declare war before taking military action have committed no violation, as are the targets when war is initiated entirely by the other party.

War often develops from initial skirmishes where identification of the initiator is difficult and both sides make allegations of aggression by the other. Slow escalation of fighting from border struggles without a clear attack is magnitude 3 and clarity 3; an example is the Chaco War of 1931-33. Border clashes often involve decision of local commanders rather than higher authority and are coded centralization 3. Frequency of violations is 2 or 3, depending on the size of initial attack that marks the beginning of the war. In the Assam War of 1962, China's initial attack covered several areas while Indian attack was restricted ({Eekelen, 1964 #470}, 94), and therefore, the frequency of China's violation is coded 3 and the India's 2. This is the only issue where the coding rules require that magnitude and clarity have the same values; they vary on the other issues.

Treatment of Wounded

Violations in the treatment of the wounded include general maltreatment by individual enemy soldiers and the destruction of hospitals or hospital ships, including the Red Cross hospitals or personnel. Destruction of hospitals potentially falls under three issue areas: treatment of civilians, prisoners of war, or treatment of wounded. Since the treaties related to wounded and sick cover both combatants and non-combatants, we decided to code the hospital bombing under the treatment of wounded. Destruction of hospital ships are double coded under the treatment of wounded as well as the high seas because the treatment of hospital ships is a specific action on the high seas. We coded wounded POW cases both under the treatment of wounded and POWs. Some cases lack information on how the wounded and sick were treated. The treatment of wounded POWs thus provides an indicator about how the wounded were generally treated.

Measures of Independent Variables

The analysis seeks to determine when states comply with the laws of war. Reciprocity complicates the analysis because non-compliance could result either from a unilateral desire to violate these norms and legal obligations or from retaliation against the violations of the other side. The essence of the analysis is to separate which conditions lead to violations regardless of the other side's acts from those that trigger reciprocal responses. The basic model of compliance has two parts then, one concerning unilateral incentives to comply or violate, and a second that responds to the opponent's acts, as can be seen in the following equation:

$$Comply_{i \to j} = \beta_{unilateral} X_{i,j} + \beta_{reciprocal} \left(X'_{i,j} \right) \left(Comply_{j \to i} \right) + \varepsilon_{i \to j} \qquad (4.1)$$

where the β's and X's are vectors of coefficients and independent variables. The $X_{i,j}$ are those variables that lead to compliance or violations unilaterally, while the $X'_{i,j}$ are those that effect whether i responds to j's violations. Later I will discuss the issues involved in estimating such a model; for now, I want to discuss the various explanatory variables examined in the analysis.

Treaty Status of Both States in Question

I have argued that international law can create a shared understanding of which acts are acceptable and which unacceptable during war. Treaty ratification is central to the creation of such a shared understanding because the act of ratification signals that the state in question accepts its legal obligation to live up to the standards set out in the treaty in question. The first set of explanatory variables address the legal acceptance by the state of the most recent treaty in that issue-area in question.

For each warring state, I code three variables for its legal acceptance of existing law, SIGN, RATIFY, and RESERV, for each issue area.[3] RATIFY is the central variable here, and it is coded 1 if the state has ratified the most recent treaty which has entered into force on the date when the war begins, and 0 otherwise. SIGN is coded 1 if the state in question has either ratified or signed but not ratified the most recent treaty in force when the war begins. This variable allows me to test whether signing or ratification is the key step in the legal acceptance of a treaty. RESERV is coded 1 if the state registered a reservation to any part of the treaty in question.[4] This variable allows me to test whether reservations weaken the effect of a treaty. Because I code only the existence of a reservation, I could not determine whether state acts violated only the parts of the treaty under that specific reservation. In this sense, I have not fully tested whether the reservation was critical to the state's behavior during wartime. Instead, I am testing whether reservations generally weaken a state's obligations under a treaty and other states' perception of its willingness to live up to the general standard of the treaty.

Under these coding rules, a state that has accepted an earlier standard but does not accept the most recent treaty is coded as not having signed or ratified the standard. Japan, for example, ratified the 1907 Hague Convention with a reservation but only signed the 1929 Geneva Convention on Prisoners of War. For the First World War, Japan is coded with SIGN, RATIFY, and RESERV all equal 1, while for the Second World War, the codes for Japan are SIGN equals 1, while RATIFY and RESERV are coded 0.

For some issue-areas at some times, there are multiple treaties currently in force that all entered into force at the same time. A state must sign or ratify all of them to qualify as having signed or ratified the current standard in that issue-area. It is coded as having a reservation if it registers a reservation to any of the treaties in question. This issue primarily arises with conduct on the high seas under the 1907 Hague Conventions where the obligations were broken into different agreements. A number of states, including notably the United States, sign and ratified only some of these obligations, leading to this situation.

As described earlier, states that fight under joint military command are treated as a single actor in the collection of the compliance data. For cases where some states under the joint command ratified the relevant treaties while others did not, I average the ratification, signing, and reservation scores for all members of the joint command by the relative military capabilities that they contribute in the war. The strongest states in the joint command are considered to set the tone for the allied forces in this method. The resulting scores then fall between 0 and 1 if the members of the joint command do not all have the same treaty status.

The analyses reported here focus on ratification by the violator and by both sides as measures of legal acceptance and legal obligation respectively. Ratification is the public act that the state in question accepts the most recent legal standard. I report analyses using signings and reservations among the additional analyses that can be found at my website.

Power Relationship

The balance of forces between the two sides, and hence their chance of winning the war, could affect the willingness of both sides to comply with the laws of war. To measure the rough power relationship of the warring sides, I use the Composite Capabilities indicators developed by the Correlates of War project. They collected annual data on six indicators of national capabilities, two demographic, two industrial, and two military, as follows:

Demographic: Total Population, Urban Population

Industrial: Iron/Steel Production, Energy Consumption

Military: Military Expenditures, Military Personnel

For a given state, each of these indicators is then divided by the world total of that indicator to give the state's proportion of the world share of that indicator, and hence its capabilities on that dimension relative to other states. These six proportions are then averaged to give the state's composite capabilities, its share of the total capabilities in the system.[5]

Where the state fight also enters my measure because it is difficult for states to project their full capabilities at a great distance from their homeland. I use the loss-of-strength gradient first introduced by Bruce {Bueno de Mesquita, 1981 #485} in *The War Trap*. First, the state where the fighting generally took place is determined for each warring dyad. The distance from each state's capital to the location of the fighting is calculated. If a state is contiguous with the state where fighting took place, the distance is considered to be 0. Each warring state's composite capabilities are then adjusted for how far the state was from the fighting using the following formula:

$$Adjusted\ Capabilities_{i\,at\,j} = \left(Composite\ Capabilities_i\right)^{\log_{10}\left(\frac{distance\ from\ i\ to\ j}{miles\ per\ day} + 10 - e\right)} \tag{4.2}$$

where miles per day is 250 before 1919, 350 from 1919 to 1945, and 500 thereafter. These adjusted capabilities give the effective power that the state in question can generate on the battlefield.

When several states fight under a unified command, I have treated them as one actor when collecting the compliance scores. To calculate the capabilities of a unified command, I then add together the adjusted capabilities of all the member states of the command at the location of the fighting. I also use the adjusted capabilities as a measure of each state's contribution to the joint command when measuring the domestic system and status of legal obligations of that command as I explain in the sections on those measures.

To measure the power relationship between two warring sides whether each is a state or a unified command, I calculate the ratio of each state's capabilities to the total of both sides. This value ranges between 0 and 1 and gives the proportion of the capabilities on the battlefield that each side possesses. This measure has been used as a measure of the probability that each side will win the war in other research ({Bueno de Mesquita, 1981 #485}). By construction, if *p (= AdjCapA/(AdjCapA+AdjCapB))* is this proportion or probability for one side of a warring dyad, then *1 - p* is its value for the other side.

Regime Type

I use the widely used Polity data for measures of regime type ({Marshall, 2002 #487}). This project has collected measures of competitiveness of executive recruitment (XRCOMP), openness of executive recruitment (XROPEN), constraints on the chief executive (XCONST), and competitiveness of political participation (PARCOMP), and regulation of participation (PARREG) for all states from 1800 to 1999 (for Polity 4). Particular scores on the first four are combined into a measure of democracy that runs from a low of 0 to a high of 10, with higher scores indicating open and free political competition for election to a constrained chief executive. Particular scores of all five measures are combined to produce a measure of autocracy that also runs from a low of 0 to a high of 10 with higher scores indicating political systems where the leader's power is unconstrained, and he or she is selected through a closed process in which few members of society participate. As these measures are well-known, I will not give the details of how each of the indicators is accumulated from these five measures; interested readers should see {Marshall, 2002 #487}. Following common practice, I judge a state to be a democracy if its democracy score minus its autocracy score is greater than or equal to 7. I also ran alternate analyses judging a state to be a democracy if the difference in its democracy and autocracy scores was 6 and further analyses entering the democracy and autocracy scores independently. These alternate analyses produced very similar results to those reported here, so I only discuss them in footnotes when they differ. Interested readers can find the results of those analysis at the website with extensions and replication materials.

Other Independent Variables

I also examine other independent variables drawn from the Correlates of War (COW henceforth) data that address the characteristics of the war itself ({Small, 1982 #488}). First, I examine which side initiated the war. In the Correlates of War coding, the initiator is the side that takes the first military action of the war, such as having their troops cross the border and attack. For the World Wars, COW only coded the states which began the fighting as the initiator, so Austria-Hungary is the initiator of World War I and Germany the initiator of World War II. As I am working with warring dyads, I have also coded as initiators any state that attacked a neutral or created a new front of the war through its intervention into the war. An example of the former is when Germany attacks the Netherlands in 1940; Germany initiated that dyadic war. An example of the latter occurs when Japan attacked the United States and the British Commonwealth in 1941, opening up new fronts in the Pacific and Southeast Asia. I do not code state that intervening in an ongoing war on existing fronts as initiators. For instance then, China is not coded as an initiator when it intervenes in the Korean War. Then there are dyadic wars where neither side is the initiator. Full details of these decisions can be found at my website.

I also look at the outcome of the war. COW codes each warring state in terms of the final outcome for its side of the war: victory, defeat, draw, or ongoing. However, these codes are based on the final result of the entire war and so do not reflect the dyadic wars I examine. Poland, for example, is coded as a victor in the Second World War. I have coded the date of termination and outcome of each dyadic war based on the surrender of one side to the other or the end of effective combat if there is no formal surrender. These codings during the World Wars are based on the outcome when the losing side surrenders even if its side won the war in the end. For instance, Germany and Austria-Hungary defeated Russia in the First World War as a consequence of the Treaty of Brest-Litovsk. Again, documentation of these decisions can be found at my website.

Finally, I also add the battle deaths per 1000 prewar population of each warring party as a measure of the intensity of the war. The battle death data and prewar population for each warring state comes from COW. Their measure of battle deaths does not try to collect civilian deaths as a consequence of the war, but in many cases, civilian deaths from bombings or counterinsurgency warfare are indistinguishable from battle deaths. Again I aggregate these average deaths for unified commands in three different ways; averaging based on the capabilities that each member brings to the unified command, the minimum and the maximum.

Estimation Issues

The nature of the data on compliance and the presumption of reciprocity pose two issues for the statistical estimation of the relationships in the data. As described earlier, each warring party's compliance with the laws of war was collected in separate measures of magnitude, frequency, centralization, and clarity of violations. These scores are scales from 1 to 4, 1 to 5 for centralization, with higher numbers indicating worse behavior, because it was easiest to collect the data in this form. The measure of compliance I use is the product of magnitude and frequency, which then ranges from 1 for full compliance to 16 for many major violations to the point where the standard is completely ignored.[6] This measure of compliance is probably an ordinal measure of compliance at best. While it is safe to say that a score of 12 (one of magnitude and frequency is scored a 4 and the other a 3) is worse than a 6 (one of magnitude and frequency is 3, the other 2), it is probably not accurate to say that the former acts were twice as bad as the latter. Treating the measure of compliance as a ratio-level variable may be assuming more information than is present in that measure. The first issue then is the ordinal nature of the dependent variable, compliance.

The common solution to this issue is to convert the compliance variable to a limited dependent variable of a few categories where we have confidence that the categories are distinct and clearly ordered. In this case, I collapse the full range of compliance into four categories, full compliance, a score of 1, meaning no violations; partial compliance, scores of 4 to 8 where the scores for both magnitude and frequency are above 1 but at least one is not greater than 2, meaning that any major violation occurs rarely; and low compliance, where major violations are not rare occurrences but do not rise to the level where the standard is ignored, and noncompliance where they do (i.e. magnitude and frequency both equal 4). I have confidence in the ordering of these four categories and analyze it using ordered multichotomous probit. This technique assumes that the four categories result from an unobserved underlying variable modeled as a linear function of the independent variables with a normally-distributed error term. In this case, we can think of the underlying variable as a full measure of compliance. We observe whether a given case falls into one of the four categories based on whether the underlying variable including error term falls with respect to three cutoff points. If it is lower than all three cutoff points, we observe full compliance, between the first and the second, high compliance, between the second and the third, low compliance, and above all means noncompliance. I estimate the coefficients of the underlying function and the cutoff points. The use of ordered probit addresses the question of our confidence in the measure of compliance.[7]

Testing for reciprocity leads directly to the second issue, simultaneity bias. If reciprocity exists, then side i's violations against side j depend in part on side j's violations against side i, and vice versa. The dependent variable, $Comply_{i\rightarrow j}$, appears on both sides of the equation as can be seen after we substitute for $Comply_{j\rightarrow i}$ into equation 4.1 earlier,

$$\begin{aligned} Comply_{i\rightarrow j} &= \beta_{uni} X_{i,j} + \beta_{recip}\left(X'_{i,j}\right)\left(Comply_{j\rightarrow i}\right) + \varepsilon_{i\rightarrow j} \\ &= \beta_{uni} X_{i,j} + \beta_{recip}\left(X'_{i,j}\right)\left(\beta_{uni} X_{j,i} + \beta_{recip}\left(X'_{j,i}\right)\left(Comply_{i\rightarrow j}\right) + \varepsilon_{j\rightarrow i}\right) + \varepsilon_{i\rightarrow j} \end{aligned} \quad (4.3)$$

where β_{uni} are the coefficients for the unilateral effects on compliance and β_{recip} are the coefficients for the reciprocal effects. The consequences of running a model with the simultaneity bias is two fold. One, the estimated coefficients will be biased, that is, their expected values will differ from the true values. In this case, the bias will be upwards because we anticipated positive effects from reciprocity ($\beta_{recip} > 0$). Two, the estimated standard errors of the coefficients will underestimate the true variability of the estimates. The combination of these two effects will be that we will reject the null hypothesis of no reciprocal effects too easily. In statistical terms, the chance of Type I error, believing our hypothesis to be supported by the evidence when it is not, is increased.

The standard response to simultaneity bias is to create instrumental variables for the included endogenous variables, here $Comply_{j \to i}$ in the equation predicting $Comply_{i \to j}$. Instruments are constructed by regressing the included endogenous variables on the included exogenous variables and several other variables not included in the regression and keeping the predicted values of that regression as the instrument for the included endogenous variable. By construction, the instrument is uncorrelated with the error terms, eliminating the bias introduced by the correlation of the included endogenous variable, here $Comply_{j \to i}$, with the error term of the equation, $\varepsilon_{i \to j}$. Instrumental variables add random variance to our estimation because the instruments cannot be as accurate as the true values of the included endogenous variables. This added variance increases the standard errors of our estimated coefficients. Using instrumental variables produces a tradeoff in terms of mean squared error; it eliminates bias in our estimates but increases variance.

I address these two issues of estimating reciprocal models on my compliance scores by performing two sets of analyses and seeing if the results are robust across them. I run ordered probit including the endogenous variable of the other side's compliance in the estimated equation. The estimated coefficients from these runs should be biased upward, and their standard errors should be underestimated. I also run two-stage least squares, which creates instruments for the other side's compliance, treating the compliance scores as continuous variables with a full range of 1 to 16. These estimates will not be as precise as those produced by ordered probit, but they will be unbiased. Further, the set of excluded variables that can be used to construct the instruments is limited because the analyses include a large number of exogenous variables. Consequently, I am only able to include one reciprocal terms in each instrumental variable analysis. My plan is that two less than perfect estimation techniques will be better than one alone.

When Do States Comply?

I now turn to the analysis of when states have complied with the laws of war. This section presents the full analysis underlying the figure of the companion chapter, explaining how I arrived at those results. The key questions are as follows:

1. Whether states makes reciprocal responses at the level of the data?
2. If so, how is reciprocity conditioned by legal obligation, legal clarity of violations, and whether they were individual or state violations?
3. Whether states show restraint when they are legally obligated?
4. Do different regime types show different levels of restrain and willingness to retaliate?
5. Does compliance vary across issues?
6. Does relative power affect compliance and reciprocity?

The analyses of this section examine what factor include the compliance of one side, which I remind the reader I refer to as the violator. To test for reciprocity, I also include the compliance of the other side, referred to as the victim. I also remind the reader that the compliance score might more accurately be called lack of compliance as the score increases with the severity and frequency of violations by the party in question. Sometimes then I will talk about the violations increasing under certain conditions; these comments should be understood as denoting lower levels of compliance. Again, positive coefficients in these analyses indicate that compliance decreases and violations increase; negative coefficients correspond to improvements in the compliance of the violator.

Declaration of War

I begin my analysis by separating out one issue-area–declaration of war–that needs to be studied separately from the others. Declaration of war is only an issue at the outbreak of war, and as such reciprocity is not an issue. The codes for compliance on other issues are for behavior across the entire war, and so we can reasonably believe that if reciprocity occurs, both sides will have high scores or low scores for the compliance measure of magnitude times frequency. Further, the codings of compliance with declaration of war force the scores of two sides to either move together or in opposite directions. We often think of the canonical case when one side attacks the other, whether the former declares war on the latter or not. The latter side is coded as being fully compliant because it was attacked. If the initiator declared war before its attack, the scores of the two sides are the same. If not, magnitude is scored as a 4 and the frequency gives the scale of the initial attack, meaning that the initiator's score for noncompliance is high. But many cases do not look like the canonical case; they involve a slow build-up of fighting along a shared border. In these cases, it is often difficult to tell which side began the fighting or even when the war began. Both sides are coded with magnitude 3 in such cases, again with frequency giving the scale of this initial fighting.

I analyze whether states declare war then separately from the other issues in the laws of war. Further, I do not test for reciprocity in this analysis, so the other side's compliance is not included. Instead, I test to see if legal commitments, regime type, initiation, and the power relationship affect whether a state declares war. I expect that states will be more likely to declare war when they have ratified the Hague Convention of 1907 relevant to the Opening of Hostilities, the more democratic their system, and when they have not initiated the war. I also test for the interaction of democracy and legal commitment to see if democracies are more likely to uphold their legal commitments. I have no clear expectations concerning the power relationship because there are two contrary arguments concerning power and declaring war. On one hand, it might be that stronger states are more willing to declare war because of they do not need the advantage of a surprise attack. On the other hand, stronger states are more likely to initiate and so more likely to launch undeclared wars.

Table 4'.1 presents the results of three ordered probit analysis of when states declare war. The dependent variable is the four categories of compliance described before, where full compliance is lowest, high compliance next, followed by low compliance, and noncompliance is the highest category. The coefficients then predict likelihood of not declaring war at its outset. I refer to the state in question as the violator and the other side as a victim, although both sides are in the analysis in different directed dyads, each as the violator in one and the victim in the other. Whether a state enters into war without a declaration is closely related to whether it initiates the war. States that do not initiate a war or new front to an existing war are likely to declare their entrance before beginning fighting. Entering whether the violator initiated the war swamps all the other variables, so I present three separate analysis, one of all cases that omits whether the violator initiated the war, and two other analyses that examine either just initiators or just states that did not initiate.[8] The pattern in Table 4'.1 is robust across the three analysis; the states most likely to comply and declare war are democracies that have ratified the relevant Hague convention. For both the analysis of all cases and just initiators, only the interaction of democracy and ratification is statistically significant. For the analysis of non-initiators, ratification is the only statistically significant predictor of a declaration of war.

Table 4'.1 about here

Initiation is the strongest predictor of whether a state enters war without a declaration, so Table 4'.2 presents an analysis of whether a state is an initiator in terms of the same variables in Table 4'.1. Power overwhelmingly determines initiation of war; the stronger a state relative to its target, the more willing it is to initiate new hostilities. Again democracies that have ratified the relevant Hague Convention are less likely to initiate war. The pattern across Tables 4'.1 and 4'.2 is that the combination of democracy and treaty ratification does restrain surprise attacks.[9]

Table 4'.2 about here

The Main Analyses

The central arguments of Chapter 3 address the nature of reciprocity in the laws of war. States respect these prewar agreements to limit violence during war because they prefer to fight under the constraints than fight an unconstrained war. Reciprocity exists in that states will tend to respond to their opponent's violations with violations of their own. The first question I address in this analysis is whether reciprocity has occurred; is compliance met with compliance and violations with violations?

Law enters the logic of reciprocity by clarifying what acts are violations and what responses are appropriate to violations. I have argued that the law of war could operate under two dynamics that enhance reciprocity. First, joint ratification of a public treaty creates a common conjecture that both sides will fight under the constraints of the treaty. If one side should then violate its commitment, the other should respond in kind. Second, closely related to this logic, ratification of a treaty signals other states that the ratifying state intends to live up to its obligations under the treaty. This effect should be unilateral if ratification creates audience costs for state leaders, and not strengthen reciprocity. I test these arguments by including whether the violator has ratified the most recent treaty on the issue and whether both sides have–joint ratification. I also test to see if legal commitments strength reciprocity by interacting these variables with the compliance of the victim. If reciprocity under joint ratification has a deterrent effect, it should also be the case that joint ratification corresponds to higher levels of compliance on average.

Treaties could also strengthen reciprocity by creating bright lines of conduct that clarify when retaliation is called for. I test for this possibility by interacting the legal clarity of the victim's violations with various reciprocal terms, the victim's compliance alone, with joint ratification and the victim's compliance, and with whether the violator has ratified and the victim's compliance. This combination of interactive terms allows me to test when legal clarity strengthens reciprocity.

Noise complicates the logic of reciprocity. When actors cannot be certain whether the violations they observe on the battlefield are the deliberate policies of the opposing state or simply individual enemy soldiers committing atrocities on their own, they cannot be certain whether they should respond on the battlefield. The logic could go either way. It could be that only deliberate state violations call for a reciprocal response, with retaliation against individual violations presenting the further problem of inadvertent escalation. The other possibility is that states may believe that there is no chance of deterring deliberate state violations, while retaliation against individual violations could convince the other side to police its own soldiers. I test to see if reciprocal responses are stronger against individual or state violations by creating dummy variables for each type.[10]

Beyond the tests of reciprocity which are interactions of the victim's compliance with other variables, I also test for the separate effects of these variables on compliance. I include the ratification status of the violator alone, joint ratification, whether the violator is a democracy, and the interactions of democracy with the two types of ratification status. These variables test for differences in average compliance. These differences could be the property of deterrence or unilateral restraint. These interactions allow me to see if democracies behave differently than other systems and if democracies take their legal obligations more seriously than other types of states.

I include seven dummy variables for issues to test for differences in average compliance across them. Because I analyze declaration of war separately from the other issues, there are eight issues in the analysis. Dummy variables for the first seven issues give how they differ on average from the excluded issue, treatment of the wounded, with an assumed coefficient of 0. Negative coefficients here denote issues with better records of average compliance than treatment of the wounded, positive coefficients worse records.

The power ratio measures the relative power of the sides. I include it to see if stronger sides commit more violations and interact it with joint ratification to see if legal restraint reduces any such tendency.

I also include other variables mentioned earlier that have a significant impact on compliance: battle deaths per 1000 prewar population as a measure of the intensity of the war, whether the violator initiated the war, whether the violator lost the war, and the interaction of whether it lost with the power ratio.

As discussed earlier, the model of reciprocity here will be estimated in two different ways. The first estimation is an ordered probit on the four categories of compliance. This analysis includes the other side's level of compliance directly and so suffers from simultaneity bias. The second estimation tries to deal with this bias by creating instruments for the other side's compliance and estimating a linear regression of the full range of compliance–the product of magnitude and frequency of violations by a warring party. The instrumental variables analyses suffer from a lack of unincluded variables that could be use to construct instruments. These analyses then assess reciprocity by only including one interaction of the victim's compliance with different combinations of legal clarity and joint ratification.

I conduct both sets of analyses three ways to test for the robustness of the results against the quality of the data. The first two columns in Table 4'.3 and 4'.4 report analyses with and without weights for the quality of the data from the data collection. The weighted analyses weight observations supported by more extensive historical documentation more than those based on sparse documentation. These weights are equal to the sum of the quality of the data for both sides of the directed dyad and so range from 1 to 8. Observations where both sides have only standardized codings for their compliance are dropped from all analyses. The third column of results in these tables reports results when all cases whether either the violator or the victim has a standardized coding are dropped from the analysis. These analyses are not weighted by the quality of the data remaining.

Table 4'.3 presents the results of the ordered probit estimations. The patterns are robust across all three variations of controls for the quality of the data. As I have discussed these patterns already in the preceding companion chapter, I will not repeat that discussion here. The full effect of reciprocity requires adding together all the relevant reciprocal terms, which are separated out at the top of Table 4'.3. The effects of ratification status, regime type, and relative power on overall compliance come next in the table. The dummy variables for the seven of the eight issues follow, with treatment of the wounded as the omitted base line category. The table ends with variables on the conditions of the war–initiation, intensity, and defeat, followed by the summary measures of each analysis.

Table 4'.3 about here

The simultaneity bias present in the ordered probit models should inflate the estimated coefficients of the reciprocal terms and gives us some pause before we accept the results reported in Table 4'.3 as definitive evidence of reciprocity in the laws of war. Instrumental variable analysis creates instruments for the reciprocal variables to address the simultaneity bias. Table 4'.4 provides the estimated coefficients for the reciprocal terms in four instrumental variable analyses under each of the three treatments of the data quality issue, meaning that twelve different analyses are reported in the table. I do not report the coefficients for the exogenous variables in these analyses. They are the same as in Table 4'.3, and the full tables of results can be found at my website for those interested. The excluded exogenous variables available for the construction of the instrumental variables limits the interactions of the reciprocal variables that we can include in any estimation.[11] The full set of exogenous variable available for the construction of instruments lacks the variation to estimate more than one of the reciprocal variables effectively; a table of the statistical tests demonstrating this can be found at my website. Each analysis then includes only one terms for reciprocity, which is interacted with joint ratification and clarity. All twelve terms are positive and statistically significant. The evidence of positive reciprocity in the ordinal probits is not the result of the upward bias induced by simultaneity. The common pattern across all these estimations are what we seek; I now turn to a technical discussion of the patterns I presented graphically in the companion chapter.

Table 4'.4 about here

<u>Reciprocity</u>

Tables 4'.3 and 4'.4 show reciprocity. Table 4'.5 sums the various reciprocal effects under different combinations of legal obligation and clarity and centralization of the other side's violations. The figures in the table give the slope of the increase in the latent variable in the ordinal probit for the compliance of the other side and the estimated standard error of each sum calculated from the variance-covariance matrix of the analysis. For instance, the latent variable underlying the violator's compliance rises by .963 for each increase in the level of the victim's violations when both sides have ratified and the violator's violations are state policy but their legal status is in dispute (the upper right cell of Table 4'.5). They are calculated from the second column of Table 4'.3. These numbers cannot be interpreted directly as an increase in violations in response to those of the victim because they are probit coefficients. They do reflect how the compliance of two warring parties move together.

Table 4'.5 about here

Legal obligation through joint ratification strengthens reciprocity, as can be seen by comparing across the columns of Table 4'.5. Although warring states do not match one another's compliance exactly, there is a strong tendency to meet violations with violations and compliance with compliance. These differences across the columns are statistically significant at the .004 level or higher, with the closest comparisons occurring when the victim's violations are definite legal violations. The added strength of reciprocity under joint ratification can be seen in Table 4'.4 by comparing the coefficients of the reciprocal effects in the bottom two rows where the victim's compliance is interacted with joint ratification and the top two rows where it is not. These coefficients can be read directly as decreases in compliance because the analysis is a regression rather than a probit. This comparison shows that joint ratification roughly doubles reciprocal responses.

The evidence on whether legal clarity strengthens reciprocity is not so clear. In Table 4'.5, legal clarity strengthens responses only when the parties are not bound by joint ratification, and the differences across the levels of legal clarity are statistically significant at the .001 level. In Table 4'.4, increasing legal clarity of violations strengths reciprocal responses as can be seen in the second and fourth rows of the table which interact legal clarity with the victim's compliance and, in the fourth row, joint ratification. The resulting effect at the clearest level of violations, when clarity equals 4, is less, however, than the terms above them where legal clarity is not interacted with the other side's behavior. This suggests that legal clarity does not have the expected effect of strengthening reciprocity, but this unexpected result may occur because of a lack of variation in the data set. Under joint ratification, most violations are definite legal violations. There are only 10 cases of violations in clear legal dispute under joint ratification, and both sides have high or full compliance in these cases. The reversed sign of legal clarity under joint ratification is based on few cases, and so we should place little weight on it.

The effects of the centralization of violations on reciprocity are negligible. The coefficients in Table 4'.3 for the interactions of the victim's compliance with individual violations is higher than that with state violations, although the difference is not statistically significant in any analysis.

Democracy and Legal Obligation

The effects of ratification mediate the effects of regime type and relative power, so I discuss these together. Table 4'.6 sums the baseline effect of the six combinations of regime type–democracy and nondemocracy–and three types of legal status–violator did not ratify, only the violator ratified, and joint ratification. These effects do not include reciprocal effects which vary with joint ratification. Democracies are *more* likely to commit violations than nondemocracies when they have not ratified the most recent treaty on the issue at hand, but commit fewer violations when they have. The effect of ratification on the baseline behavior of a democracy (the difference between the left and middle cells in the top row of the table) is statistically significant at more than the .001 level. Ratification by itself has no real effect on the behavior of a nondemocracy. Joint ratification, and presumably the anticipation of reciprocity, is necessary to restrain a nondemocracy. The difference between joint ratification and when the violator alone has ratified for nondemocracies is statistically significant at the .002 level.[12] This difference is statistically significant for democracies at the .078 level.[13]

Table 4'.6 about here

Aerial bombardment accounts for part of this pattern, but not all of it. No party in the data set ever has a legal obligation on aerial bombardment because the draft treaties from the 1930s, 1956 and 1970 were never signed, much less ratified. Historically, democracies have conducted most of the large campaigns of aerial bombardment against civilians. To check this possibility, Table 4'.7 reports the results of replications of Table 4'.3 excluding all cases of aerial bombardment. I only report the coefficients for democracy, ratification status, power ratio, and their interactions in the interest of brevity; nor do I report replications of the instrumental variable analyses of Table 4'.4 as they produce the same pattern. The tendency of democracies to commit more violations when they are not legally bound is reduced by about one-third when dropping aerial bombardment from the data. Nevertheless, the pattern that democracies commit more violations when they are not legally bound and fewer violations when they are still holds. Aerial bombing does not completely explain this pattern; it is something deeper about how democracies fight.

Table 4'.7 about here

Relative Power

Relative power enters the multivariate analyses in several places, making its full effect complex. Stronger sides are less likely to comply unless they are restrained by legal obligation through joint ratification. The coefficient for power ratio alone is positive and statistically significant. The effect of power when joint ratification exists, the sum of power ratio and its interaction with joint ratification, is not. Overall, the effects of power on compliance are smaller than those of reciprocity and democracy.

Issue-Area

Compliance varies significantly across issues in the laws of war. The estimated coefficients for each issue in Table 4'.3 gives the difference in average compliance between that issue and treatment of the wounded, which is the omitted category. Chemical and biological weapons (CBW) has the highest average level of compliance. After CBW, a group of issues–armistice/cease fire, conduct on the high seas, and aerial bombing–have the next highest levels of compliance. The difference between the coefficient for CBW and any of these three issues is statistically significant at the .001 level. None of the differences with this group of three issues is statistically significant at the .1 level. Protection of cultural property and treatment of the wounded come next in typical levels of compliance. The differences between both of these issues and armistice/cease fire are statistically significant at the .054 level or higher, but the differences with conduct on the high seas or aerial bombing are not. Prisoners of war has even less average compliance, and the differences between it and aerial bombing and treatment of the wounded are statistically significant at the .011 and .043

levels respectively. Treatment of civilians produces the least compliance. The difference between it and every other issue but POWs is statistically significant. There is then a ladder of average compliance, with CBW producing the best record, followed by a group of armistice/cease fire, conduct on the high seas, and aerial bombing, then a pair of protection of cultural property and treatment of the wounded, trailed by POWs and treatment of civilians.

Initiation and Intensity of War

To complete this discussion of estimated effects, more intense wars as measured by battle deaths per 1000 prewar population have more violations. Initiators are also less likely to comply as are losers. The effect of losing is reduced by power ratio, so that weak losers commit more violations than strong ones.

To summarize this section, I pull together the relative magnitude of all the effects I have discussed. The relative magnitude can be judged by comparing the products of the estimated coefficients in Tables 4'.3 and 4.5 with the typical variation in each of the variables. The issue has the largest impact; the difference in average compliance between CBW and treatment of civilians is larger than any of the other differences considered here. Next and comparable in magnitude to issue is reciprocity when both parties are legally obligated through joint ratification, and then democracies that have ratified. Their effects on compliance are roughly comparable. From Table 4'.5, a shift of 2 levels in the compliance of the other side produces a movement of 1.5 to 2.0 in the latent variable underlying the violator's noncompliance under joint ratification. Changing a democracy from not ratifying to doing so lowers that latent variable by about 1.1 to 1.5 in Table 4 depending on whether the victim has also ratified. Shifting from the issue with the best compliance, CBW, to the issue with the worst, treatment of civilians, raises the noncompliance latent variable by about 1.5. All of these effects are much larger than any of the other variables in the analysis. The effects of issue and reciprocity under joint ratification are roughly one level of compliance; changing the issue from chemical and biological warfare to treatment of civilians reduces compliance one level, such as from high to low, and shifting the victim's compliance from full to none has about the same effect. After these two, the unilateral restraint of a democracy which has ratified the relevant treaty has the next biggest effect. Losing the war at hand and increasing the intensity of the war produce similar and lesser reductions in compliance. The strength of reciprocal responses does not vary appreciably with either legal clarity or whether the violations are state policy or the result of individual acts nor does relative power have much effect on compliance.

Multivariate Analysis of Reciprocity and Total Compliance

The companion chapter presented dyadic analysis of reciprocity–the difference between the two sides' compliance on a given issue–and total compliance–the sum of their compliance scores–using tables to show the patterns there. As with the analysis of compliance, high scores on these variables mean reciprocity is weaker and total compliance is lower. This section presents multivariate analysis that extends and supports those results. I have already summarized the main conclusions here in the companion chapter, so I focus on the details of the analysis here.

The observation in these analyses is the warring dyad- issue, so the variables tested earlier change from directed dyad to dyad. Two variables–joint ratification and only one side ratified–assess ratification status in the dyad. I interact these variables with whether there is a democracy in the dyad for joint ratification and create another variable for when the only side that has ratified is a democracy. The latter allows to me test whether unilateral restraint by democracies undermines reciprocity and produces lower levels of total compliance. For the analyses of reciprocity, I include maximum clarity of violations, the greater of the two clarity scores in the dyad, to capture whether reciprocity is stronger in the face of clear, legal violations. I examine whether reciprocity varies with the centralization of violations by creating two variables, one for cases where both sides commit state violations and the other for when both sides commit individual violations. I interact these with joint ratification to investigate how legal obligation shapes reciprocity at the state level and on the battlefield. I group the issues into low noise issues–Aerial Bombing, Armistice/Cease Fire, CBW, and Conduct on the High Seas–and high noise issues, including a dummy variable for the former and an interaction of low noise issue with joint ratification. I test for the effects of relative power with power differential–the power ratio for the stronger side in the dyad (and so this variable ranges from .5 when the sides are equal to 1). I also include the minimum battle deaths per 1000 prewar population as an indicator of the intensity of the war.

Table 4'.8 presents the results of an ordinal probit analysis of reciprocity. As with the analysis of compliance, I present three analyses that vary on how the issue of the quality of the data is handled. The first column treats all cases equally, the second weights the case by the sum of the quality of data for each side, and the third column excludes any case where one side has a standardized coding. Ratification has complicated effects. As in the tables in the companion chapter, unilateral ratification by a democracy weakens reciprocity, although the effect is not statistically significant in Table 4'.8 (the appropriate test is for the sum of Only One Side Ratified and Only Democracy Ratified. Joint ratification strengthens reciprocity indirectly by changing how the parties respond in different situations. Dyads without joint ratification respond to state and individual violations similarly; reciprocity is stronger when both commit the same type of violation, and the difference between the two is not statistically significant. Under joint ratification, reciprocity is stronger when both sides commit individual violations than state violations, and this difference has strong statistical significance (better than .001). States may respond more strongly to individual than state violations under joint reciprocity because retaliation has already failed to deter the other side when state violations are committed, while they might be sufficient to induce the other side to discipline its soldiers committing violations against state policy. Joint ratification also changes the effect of low noise issues on reciprocity; without it, those issues have lower records of reciprocity, but joint ratification eliminates that difference.

Table 4'.8 about here

Legal clarity has a strong effect in these analyses, but it is subject to a major qualification. That variable has its lowest score when neither side commits any violations, meaning that reciprocity is perfect. This coefficient then may simply be the result that it also tracks which dyads have any violations. Large differences in power between the two sides does weaken reciprocity in these analyses. Finally, it does not appear that more intense wars have better or worse records of reciprocity.

Table 4'.9 reports parallel analyses for total compliance–the sum of the compliance of both sides. Again, compliance deteriorates as this variable increases, so positive coefficients reflect less total compliance. Reciprocity matters because we hope it induces compliance through the threat of retaliation. Reciprocity clearly induces better compliance in Table 4'.9. Recall that higher reciprocity scores and higher levels of total compliance correspond to a greater difference between the compliance of the two sides and more and worse violations by both. The positive and highly significant coefficient for reciprocity shows that reciprocity leads to better compliance. Joint ratification produces higher levels of total compliance, as shown by its negative coefficient. Democracy slightly strengthens this effect. Unilateral ratification, with or without a democracy being the ratifying side, produces a small improvement in total compliance. This could result from restraint by the ratifying side. Low noise issues have much better records of total compliance. Power difference has only a weak effect in undermining reciprocity, but it noticeably improves total compliance. Reciprocity is weaker and total compliance better in wars between unequal sides suggesting that the stronger side can deny the weaker the ability to respond in kind to any violations that it commits. Finally, intense wars experience higher levels of violations, which is consistent with the analysis of compliance reported earlier.

Table 4'.9 about here

Searching for Firewalls with Numbers

Firewalls separate the different issues in the laws of war to prevent a failure on one issue from spreading to other issues. A test for firewalls examines whether compliance by one side on one issue affects the compliance of the other side on a different issue. The ideal test would be include the other side's compliance on all other issues, using instrumental variables to control for simultaneity bias discussed earlier (as suggested by Franzese and Hays ()). Unfortunately, we lack the information to construct reliable instruments for all these reciprocal variables. The only variables available to identify compliance by issue-area are the issue dummies. Given the difficulties of constructing valid instruments for more than one reciprocal variable, the ideal instrumental variable analysis of cross-issue reciprocity cannot be done with this data set.

The observation in this test then is the directed warring dyad, not the warring directed dyad-issue as it is in the analysis of compliance. I take the residuals of the instrumental variables analysis including the compliance of the other side interacted with the legal clarity of its violations weighted by the quality of the data from Table 4'.4 (middle cell of the second row of that table). I collapse the data set so that I have the residuals on all eight issues for both sides for each directed dyad. Table 4'.10 present the full set of cross-issue correlations of the residuals. Of the 28 correlations reported there, only five are statistically significant at the .1 level and only one at the .05 level. The largest correlation, that of protection of cultural property and conduct on the high seas, is negative, contradicting cross-issue retaliation as an unusually high level of violations by one side on one issue is linked to the other side have an unusually high level of compliance on the other. Table 4.15 does not support cross-issue retaliation generally.

Table 4'.10 about here

Table 4'.11 provides a parallel analysis of looking at the correlations of residuals across issues for each warring party on its own. Do sides that tend to commit high levels of violations on a given issue consistently commit more violations on another? Here the evidence is much stronger than compliance by warring states is correlated across issues. Of the 28 correlations in Table 4'.11, 15 are positive and statistically significant at the .05 level, and eight are statistically significant at higher than the .001 level. These correlations suggest that the residuals do contain determinants of compliance not included in the statistical analysis. The failure to find a pattern of cross-issue correlation across the sides while strong patterns exist in the cross-issue correlations of each side on its own suggests that firewalls do exist across issues in the laws of war.

Table 4'.11 about here

Duration Analysis of First Violations

As discussed in the companion chapter, duration analysis of first violations tests the hypothesis that violations comes early in war rather than late. This section presents the details of that analysis. The hypothesis to be tested is that the hazard rate of a first violation declines as the war progresses. I test the shape of the hazard function by fitting a parametric model to the data. Statistical tests on the parameters tell us whether the hazard rate is increasing, decreasing, or constant over time. A variety of parametric models are available, and they make different assumptions about how the hazard rate could vary over time. An exponential model assumes that the hazard rate is fixed, a Weibull model assumes that it is monotonic, always increasing or decreasing with the direction determined by its single parameter, and logistic models, such as the log-logistic or log-normal, allow the hazard rate to be increasing over some time periods and decreasing over others. All of these parametric models are special cases of a generalized gamma distribution which has two parameters. Depending on the values of these two parameters, we can determine which of these special cases seems to fit the data best and then examine how the estimated hazard rate of that distribution changes over time.

Table 4'.12 presents the results of these parametric survival analyses. Time is measured in days until the first violation or the end of the war. I also include the variables examined earlier to control for how the hazard rate varies across cases. I convert the violator's battle deaths per 1000 prewar population into a death rate per day by dividing it by the length of the war. I do this because the casualties across the entire war are heavily affected by the length of the war, and the conversion to a daily death rate eliminates the possibility of including the duration of the war in the estimation. The first column of Table 4'.12 presents the results of the generalized gamma distribution. The scale parameter shows that a log-normal distribution fits the data best; the generalized gamma distribution reduces to a log-normal distribution when the scale parameter, κ, equals 0. Here a statistical test for whether the scale parameter differs from 0 does not reject the null hypothesis that a log-normal distribution fits the data. The second column of Table 4'.12 presents the results of an estimation fitting a log-normal distribution to the data; the results are very close to those from the generalized gamma distribution as we would expect from the test. The shape parameter of both models allows us to tell whether the hazard rate is falling or rising across time. When the shape parameter σ is greater than 1, the hazard rate rises first and then falls with the turnover point coming earlier as σ increases.[14]

Table 4'.12 about here

The models in the first two columns of Table 4'.12 assume proportional risks across the variables. We can test this assumption by running a Cox proportional hazard model and conducting a nonproportionality test on the Schoenfeld residuals (see [Box-Steffensmeier, 2004 #461], Ch. 8 for a discussion of such tests). The Cox model does not assume a form of the hazard function as the parametric models do, but instead tests for how the pattern of survival times varies with the included variables. The test shows that the risks associated with two variables, the issues of armistice/cease-fire and CBW, are not proportionate. Visual inspection of the graphs of estimated hazard rates of both reveal that the hazard rate of each rises and then falls with the turnover point coming much later in the war than is the case for the hazard rate overall. This pattern arises for both issues for clear reasons. A side cannot violate an armistice or cease fire until one has been in place, and there has to be a period of fighting before a cease fire can be agreed to. As seen in the earlier analyses, chemical and biological weapons is one area where the standard is often observed. Many of the cases of the use of such weapons occur during the First World War when such weapons came into use during 1915, almost a year after the main warring parties had been fighting. The observed hazard rate for CBW reflects this observation, rising to its peak hazard about one year into a war. The final column of Table 4'.12 controls for the nonproportional hazards of these two variables by including an interaction of each with the logarithm of the time until first violation or the end of the war if no violation occurs. There is no substantive change in the hazard rate from these interactive terms, although the fit of the model is noticeably improved.

Reciprocity poses a endogeneity problem in that the first violation of the other side is not independent of the continued compliance of the side in question. As with the ordered probit analyses earlier, the following survival analysis of reciprocal responses should be viewed conservatively then. To assess reciprocity, I include whether the other side has committed a violation. Cases where the other side has committed a violation while the side in question has not yet are then split into two cases at the time of that violation by the other side. Cases where both sides committed first violations on the same day were not considered as reciprocal responses to one another. I conducted the same steps of the analysis as before, using a generalized gamma distribution to determine the appropriate parametric form and tested the hypothesis that the risks induced by the variables are proportional using the Schoenfeld residuals of a Cox model. The two variables that posed nonproportional risks were whether the other side had committed a violation and CBW, so I added interactions of these variables with the natural logarithm of time. Table 4'.13 presents the results of this final analysis estimated with a log-normal distribution as indicated by the generalized gamma distribution.

Table 4.'13 about here

Finally, I turn to the effects of the variables on the hazard rates of first use in Tables 4.17, and 4.18. The coefficients in these Tables indicate whether the variable in question makes first use more likely, if the coefficient is negative, or less likely, if the coefficient is positive. The pattern of results is the same as reported earlier; the variables which reduced overall compliance in the earlier analyses made first use more likely here. Again, my interest in the survival analyses lies primarily in the shape of the hazard function, not in how the variables shift those hazards.

Dry Holes

As I mentioned at the beginning of this chapter, I conducted many other specifications that those reported here. I explored a large number of other plausible patterns that upon testing did not prove fruitful. Some of these other specification may have already occurred to the reader. This section briefly explains the “dry holes” that I prospected in reaching the reported results. The interested reader can find the results of these estimations at my website.

First, several plausible arguments about how reciprocity varies receive no support when they are included in the analysis. Some argue that democracies lack the ability to reciprocate, allowing autocracies to violate international law without consequence. However, whether the violator is a democracy has no statistically or substantially significant effect on the violator's response to the victim's compliance, even when including the interaction of joint ratification, democracy, and the victim's compliance. There is some evidence that dyads that are unequal in power have less reciprocity but more total compliance. However, relative power as measured by the power ratio has no effect on the size of reciprocal responses, so it is unclear whether the weaker side cannot retailiate or whether the stronger side is restrained.

Second, signing a treaty but not ratifying it has no significant effect on behavior. Ratification is the key signal of intent.

Table 4'.1

Ordered Probit Analysis Predicting Failure to Declare War

Variable	All Cases	Just Initiators	No Initiators
Violator Ratified Treaty?	-.246, .190, n.s.	.261, .274, n.s.	-.748, .297, .016
Violator Democracy	-.070, .244, n.s.	.235, .357, n.s.	-.517, .372, n.s.
Violator Democracy times Ratification	-.824, .398, .039	-1.343, .692, .052	.295, .452, n.s.
Power Ratio	.951, .300, .002	.790, .479, .099	.062, .452, n.s.
First Cutpoint (μ_1)	.368	-.181	.242
Second Cutpoint (μ_2)	1.324	.959	1.505
Third Cutpoint (μ_3)	1.809	1.486	none: only 3 levels
N	222	86	136
Log-Likelihood	-232.1	-109.7	-88.88
χ^2	21.48 w/4 d.f.	7.44 w/4 d.f.	10.75 w/4 d.f.
Significance Probability of Model	.0003	n.s.	.030
Pseudo R^2	.044	.033	.057

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

Constant is set to 0 to identify cutpoint parameters.

Table 4'.2

Probit Analysis Predicting War Initiation

Variable	
Violator Ratified Treaty?	-.205, .214, n.s.
Violator Democracy?	-.012, .282, n.s.
Violator Democracy times Ratification	-.748, .438, .088
Power Ratio	1.349, .340, >.001
Cutpoint	.807
N	222
Log-Likelihood	-136.47
χ^2	23.47 w/4 d.f.
Significance Probability of Model	.0001
Pseudo R^2	.079

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

Constant set to 0 to identify cutpoint parameter.

Table 4'.3

Ordered Probit Analysis of Noncompliance with the Laws of War

Variable	Cases Unweighted by Data Quality	Cases Weighted by Data Quality	Only Cases without Standardized Codings
Reciprocal Variables			
Victim's Noncompliance	-.288, .289, n.s.	-.5 16, .282, .067	-.434, .349, n.s.
Clarity of Victim's Violations times Victim's Noncompliance	.173, .051, .001	.181, .049, <.001	.240, .058, <.001
Joint Ratification times Victim's Noncompliance	1.153, .353, .001	1.415, .343, <.001	1.637, .435, <.001
Clarity of Victim's Violations times Joint Ratification times Victim's Noncompliance	-.232, .069, .001	-.280, .069, <.001	-.339, .085, <.001
Individual Violations times Victim's Noncompliance	.164, .158, n.s.	.317, .154, .040	.158, .181, n.s.
State Violations times Victim's Noncompliance	.078, .168, n.s.	.261, .164, n.s.	.115, .191, n.s.
Non-Reciprocal Variables			
Joint Ratification	-.396, .372, n.s.	-.7 37, .373, .048	-.658, .461, n.s.
Violator Ratified	-.006, .167, n.s.	-.011, .175, n.s.	-.211, .210, n.s.
Violator Democracy	.608, .140, <.001	.668, .135, <.001	.632, .155, <.001
Violator Democracy times Joint Ratification	-.001, .298, n.s.	.273, .306, n.s.	.359, .404, n.s.
Violator Democracy times Violator Ratified	- .814, .304, .007	-1.153, .312, <.001	-1.240, .407, .002

Power Ratio	.628, .234, .007	.588, .235, .012	.521, .273, .056
Power Ratio times Joint Ratification	-.6 70, .287, .019	-.4 90, .293, .094	-.387, .351, n.s.
Aerial Bombing	-.192, .194, n.s.	-.155, .198, n.s.	-.207, .230, n.s.
Armistice	- .502, .185, .007	- .440, .188, .019	-.562 .213, .008
Chemical and Biological Warfare	-1.138, .167, <.001	-1.023, .169, <.001	-1.101, .199, <.001
Treatment of Civilians	.440, .134, .001	.483, .146, .001	.359, .183, .049
Protection of Cultural Property	-.005, .185, n.s.	-.013, .207, n.s.	-.025, .322, n.s.
Conduct on the High Seas	- .341, .164, .038	-.207, .169, n.s.	-.349, .204, .087
Prisoners of War	.215, .135, n.s.	.297, .147, .043	.179, .179, n.s.
Violator Initiator	.319, .079, <.001	.368, .078, <.001	.514, .093, <.001
Violator Battle Deaths per 1000 Population	.024, .0029, <.001	.024, .0028, <.001	.026, .0035, <.001
Violator Lost	.602, .158, <.001	.524, .158, .001	.488, .191, .011
Violator Lost times Power Ratio	- .772, .272, .005	- .639, .277, .021	-.594, .336, .077
First Cutpoint (μ_1)	0.81	0.70	0.93
Second Cutpoint (μ_2)	2.45	2.17	2.37
Third Cutpoint (μ_3)	3.65	3.44	3.81
N	1066	1066	798
Log-Likelihood	-935.44	-955.33	-645.93
χ^2	702.0 w/24 d.f.	795.0 w/24 d.f.	636.9 w/24 d.f.
Significance Probability of Model	<.0001	<.0001	<.0001

Pseudo R^2	.273	.294	.330

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level. The omitted category for the dummy variables of the issue-areas is treatment of the wounded. Constant is set to 0 to identify cutoff parameters.

Table 4'.4

Coefficients for Reciprocal Variables from Instrumental Variable Analyses of Noncompliance with the Laws of War

Instrumented Reciprocal Variable	Cases Unweighted by Data Quality	Cases Weighted by Data Quality	Only Cases without Standardized Codings
Victim’s Noncompliance	.203, .102, .046	.330, .091, <.001	.349, .107, .001
Clarity of Victim’s Violations times Victim's Noncompliance	.043, .021, .042	.072, .020, <.001	.077, .023, .001
Joint Ratification times Victim's Noncompliance	.368, .178, .039	.650, .172, <.001	.655, .199, .001
Clarity of Victim's Violations times Joint Ratification times Victim's Noncompliance	.074, .036, .040	.134, .036, <.001	.134, .043, .002

Each line reports the estimated coefficients for an instrumental variable analysis where the listed variable is the endogenous variable. I have omitted the estimated coefficients for the exogenous variables which are the same as those included in the analyses reported in Table 1; they and summary statistics can be found in Supplemental Tables 2 through 5. Supplemental Table 6 provides tests of the strength of the instruments.

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

Table 4'.5

Estimated Reciprocal Effects of Ratification, Legal Clarity, and Centralization

Legal Clarity of Victim's Violations with State Violations	Without Joint Ratification	Joint Ratification
Violations in Legal Dispute	.108, .136	.963, .170
Probable Legal Violations	.289, .102	.865, .123
Definite Legal Violations	.470, .084	.766, .090
Legal Clarity of Victim's Violations with Individual Violations		
Violations in Legal Dispute	.164, .149	1.019, .180
Probable Legal Violations	.345, .117	.921, .136
Definite Legal Violations	.526, .100	.822, .106

Each cell reports the estimated derivative of Violator's Compliance followed by its estimated standard error. These estimates are calculated from the estimates of Table 1 weighted for the quality of the data (the second column of that table) and the estimated variance-covariance matrix of that analysis. These estimated derivatives are probit coefficients and so do not directly translate into changes in compliance. They do allow a comparison of relative magnitudes of reciprocal effects across these nine situations.

Table 4'.6

Estimated Unilateral Effects of Ratification Status and Regime Type

	Violator Did Not Ratify	Only Violator Ratified	Joint Ratification
Democracy	.668, .135	-.496, .268	-1.205, .312
Nondemocracy	0	-.011, .175	-.993, .298

Each cell reports the estimated unilateral effect of ratification status for regime type followed by its estimated standard error. These estimates are calculated from the estimates of Table 1 weighted for the quality of the data (the second column of that table) and the estimated variance-covariance matrix of that analysis. Power ratio is set to its mean of . 5 for the third column. These estimated derivatives are probit coefficients and so do not directly translate into changes in compliance. They do allow a comparison of relative magnitudes of reciprocal effects across these nine situations.

Table 4'.7

Ordered Probit Analysis Predicting Noncompliance with the Laws of War dropping Aerial Bombing

Variable	Cases Unweighted by Data Quality	Cases Weighted by Data Quality	Only Cases without Standardized Codings
Joint Ratification	-.819, .419, .051	-1.196, .432, .006	-1.102, .547, .044
Violator Ratified	-.025, .175, n.s.	-.040, .184, n.s.	-.216, .220, n.s.
Violator Democracy	.408, .181, .024	.450, .182, .013	.371, .216, .086
Violator Democracy times Joint Ratification	-.078, .301, n.s.	.168, .309, n.s.	.216, .412, n.s.
Violator Democracy times Violator Ratified	-.529, .325, n.s.	-.810, .336, .016	-.783, .442, .076
Power Ratio	.327, .283, n.s.	.221, .295, n.s.	-.075, .358, n.s.
Power Ratio times Joint Ratification	-.412, .330, n.s.	-.208, .345, n.s.	.175, .421, n.s.

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

The estimations include all of the variables in Table 4'.3. I present only the estimated coefficients for the variables above to focus on how they change when the aerial bombing cases are dropped from the analysis.

The omitted category for the dummy variables of the issue-areas is treatment of the wounded.

Constant is set to 0 to identify cutoff parameters.

Table 4'.8

Ordered Probit Analysis of Reciprocity

Variable	Cases Unweighted by Data Quality	Cases Weighted by Data Quality	Only Cases without Standardized Codings
Joint Ratification	.132, .247, n.s.	.061, .248, n.s.	.091, .312, n.s.
Joint Ratification and Democracy in Dyad	-.264, .212, n.s.	-.137, .206, n.s.	-.325, .257, n.s.
Only One Side Ratified	-.010, .174, n.s.	-.005, .177, n.s.	-.250, .218, n.s.
Only Democracy Ratified	.221, .194, n.s.	.202, .182, n.s.	.373, .232, n.s.
Maximum Clarity of Violations	.888, .076, <.001	.835, .074, <.001	.864, .082, <.001
Both Sides Committed State Violations	-.922, .260, <.001	- .705, .223, .002	-.742, .268, .006
Both Sides Committed Individual Violations	-1.245, .235, <.001	-1.122, .247, <.001	-1.331, .313, <.001
Joint Ratification times State Violations	.608, .365, .096	.460, .309, n.s.	.555, .376, <.001
Joint Ratification times Individual Violations	-.383, .324, n.s.	-.266, .348, n.s.	-.236, .468, n.s.
Low Noise Issue	.755, .205, <.001	.708, .200, <.001	.761, .241, .002
Joint Ratification times Low Noise Issue	- .792, .273, .004	- .756, .262, .004	-.706, .316, .025
Power Difference	.977, .410, .017	.917, .408, .025	.471, .490, n.s.
Minimum Battle Deaths per 1000 Population	.0097, .0069, n.s.	.0009, .0068, n.s.	-.001, .008, n.s.
First Cutpoint (μ_1)	3.54	3.37	3.11
Second Cutpoint (μ_2)	5.41	5.03	4.90

Third Cutpoint (μ_3)	6.84	6.62	not needed
N	533	533	399
Log-Likelihood	-345.44	-368.85	-243.57
χ^2	270.3 w/13 d.f.	236.1 w/13 d.f.	188.8 w/13 d.f.
Significance Probability of Model	<.0001	<.0001	<.0001
Pseudo R^2	.281	.242	.279

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level. Constant is set to 0 to identify cutoff parameters.

Table 4'.9

Ordered Probit Analysis of Total Compliance

Variable	Cases Unweighted by Data Quality	Cases Weighted by Data Quality	Only Cases without Standardized Codings
Reciprocity	.590, .075, <.001	.532, .073, <.001	.642, .091, <.001
Joint Ratification	- .557, .173, .001	-.653, .182, <.001	-.693, .225, .002
Joint Ratification and Democracy in Dyad	-.176, .166, n.s.	-.111, .166, n.s.	-.124, .202, n.s.
Only One Side Ratified	-.2 58, .143, .071	-.221, .146, n.s.	-.266, .170, n.s.
Only Democracy Ratified	.199, .157, n.s.	.211, .151, n.s.	.164, .187, n.s.
Low Noise Issue	-1.529, .146, <.001	-1.477, .148, <.001	-1.595, .173, <.001
Joint Ratification times Low Noise Issue	.136, .203, n.s.	.191, .203, n.s.	.281, .242, n.s.
Power Difference	-.712, .330, .031	-1.050, .335, .002	-.904, .397, .023
Minimum Battle Deaths per 1000 Population	.033, .0056, <.001	.038, .0055, <.001	.039, .0066, <.001
First Cutpoint (μ_1)	-2.01	-2.25	-2.06
Second Cutpoint (μ_2)	-1.24	-1.59	-1.36
Third Cutpoint (μ_3)	-0.42	-0.88	-0.72
Fourth Cutpoint (μ_4)	0.21	-0.38	-0.29
Fifth Cutpoint (μ_5)	0.98	0.40	0.53
Sixth Cutpoint (μ_6)	1.73	1.23	1.39
N	533	533	399

Log-Likelihood	-772.06	-803.70	-567.01
χ^2	297.8 w/9 d.f.	298.0 w/9 d.f.	229.7 w/9 d.f.
Significance Probability of Model	<.0001	<.0001	<.0001
Pseudo R^2	.162	.156	.168

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level. Constant is set to 0 to identify cutoff parameters.

Table 4'.10

Correlations of Residuals Between Warring Parties Across Issues

	Side B's Residual						
Side A's Residual	Aerial Bombing	Armistice	Chemical and Biological Weapons	Treatment of Civilians	Cultural Property	Conduct on High Seas	Prisoners of War
Armistice	.121 n.s.						
Chemical and Biological Weapons	.016 n.s.	.155 n.s.					
Treatment of Civilians	-.047 n.s.	.173 n.s.	.028 n.s.				
Cultural Property	-.137 .085	.045 n.s.	-.011 n.s.	.148 .027			
Conduct on High Seas	.017 n.s.	.148 n.s.	.100 n.s.	.157 .068	-.165 .055		
Prisoners of War	.138 .083	-.109 n.s.	.109 n.s.	.078 n.s.	.078 n.s.	.048 n.s.	
Treatment of Wounded	.046 n.s.	.069 n.s.	-.018 n.s.	.017 n.s.	-.051 n.s.	-.039 n.s.	.074 n.s.

Each cell lists the bivariate correlation between the residuals of the corresponding issues with its statistical significance below if it is higher than the .1 level.

Table 4'.11

Correlations of Residuals Within Warring Parties Across Issues

	Side A's Residual						
Side A's Residual	Aerial Bombing	Armistice	Chemical and Biological Weapons	Treatment of Civilians	Cultural Property	Conduct on High Seas	Prisoners of War
Armistice	-.151 n.s.						
Chemical and Biological Weapons	.163 <.001	.048 n.s.					
Treatment of Civilians	.260 <.001	-.038 n.s.	.142 .043				
Cultural Property	.196 .013	.093 n.s.	.229 .001	.185 .006			
Conduct on High Seas	.329 <.001	.146 n.s.	.313 <.001	.001 n.s.	.166 .053		
Prisoners of War	.040 n.s.	.113 n.s.	.221 .002	.283 <.001	.164 .015	.126 n.s.	
Treatment of Wounded	-.006 n.s.	.103 n.s.	.051 n.s.	.374 <.001	.369 <.001	.012 n.s.	.292 <.001

Each cell lists the bivariate correlation between the residuals of the corresponding issues with its statistical significance below if it is higher than the .1 level.

Table 4'.12

Results of Parametric Survival Models Not Including Retaliation

	Generalized Gamma Distribution	Lognormal Distribution	Lognormal with Correction for Nonproportional Hazards
Scale Parameter (κ)	.213, .158, n.s.		
Shape Parameter (σ)	2.699, .144, <.001	2.840, .094, <.001	2.585, .085, <.001
Independent Variables			
Joint Ratification	-.382, .637, n.s.	-.433, .638, n.s.	-.674, .584, n.s.
Violator Ratified	.307, .454, n.s.	.322, .458, n.s.	.196, .416, n.s.
Violator Democracy	-1.131, .351, .001	-1.110, .355, .002	-.820, .323, .011
Violator Democracy times Joint Ratification	-.327, .809, n.s.	-.233, .819, n.s.	-.441, .749, n.s.
Violator Democracy times Violator Ratified	1.404, .813, .084	1.289, .820, n.s.	1.142, .748, n.s.
Power Ratio	-2.150, .624, .001	-2.249, .627, <.001	-1.963, .575, .001
Power Ratio times Joint Ratification	.010, .787, n.s.	.165, .779, n.s.	.169, .716, n.s.
Aerial Bombing	.569, .435, n.s.	.511, .429, n.s.	.133, .400, n.s.
Armistice	2.879, .447, <.001	2.787, .440, <.001	-4.495, .758, <.001
Armistice times Log(Time)			1.483, .151, <.001
Chemical and Biological Warfare	3.458, .465, <.001	3.467, .461, <.001	-.786, .984, n.s.
CBW times Log(Time)			.737, .168, <.001
Treatment of Civilians	-2.232, .400, <.001	-2.246, .411, <.001	-2.199, .374, <.001

Protection of Cultural Property	-1.375, .547, .012	-1.357, .566, .017	-1.298, .515, .012
Conduct on the High Seas	1.237, .430, .004	1.191, .433, .006	1.035, .393, .009
Prisoners of War	-.796, .408, .051	-.783, .418, .061	-.805, .380, .034
Violator Initiated War?	-.960, .205, <.001	-.927, .207, <.001	-.717, .191, <.001
Violator Battle Death Rate	-.370, .109, .001	-.376, .116, .001	-.241, .103, .019
Violator Lost	.661, .425, n.s.	.670, .430, n.s.	.382, .395, n.s.
Violator Lost times Power Ratio	-2.035, .759, .007	-2.092, .762, .006	-1.557, .703, .027
Constant	7.596	7.422	7.303
N	1248	1248	1248
Log Likelihood	-1564.8	-1565.7	-1505.1
χ^2	371.5 w/18 d.f.s	390.7 w/18 d.f.s	511.8 w 20 d.f.s
Significance Probability of Model	<.0001	<.0001	<.0001

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

The omitted category for the dummy variables of the issue-areas is treatment of the wounded.

Table 4'.13

Results of Parametric Survival Model Including Retaliation

	Lognormal with Correction for Nonproportional Hazards
Shape Parameter (σ)	2.772, .088, <.001
Reciprocal Variables	
First Violation by Other Side?	-8.985, .888, <.001
Log(Time since First Violation by Other Side)	1.347, .156, <.001
Independent Variables	
Joint Ratification	-.739, .646, n.s.
Violator Ratified	.438, .457, n.s.
Violator Democracy	-.928, .379, .014
Violator Democracy times Joint Ratification	.292, .902, n.s.
Violator Democracy times Violator Ratified	.811, .920, n.s.
Power Ratio	-2.522, .638, <.001
Power Ratio times Joint Ratification	.290, .789, n.s.
Aerial Bombing	.457, .430, n.s.
Armistice	2.671, .432, <.001
Chemical and Biological Warfare	.108, .954, n.s.
CBW times Log(Time)	.570, .158, <.001
Treatment of Civilians	-2.071, .383, <.001
Protection of Cultural Property	-1.511, .473, .001
Conduct on the High Seas	1.208, .421, .004
Prisoners of War	-.700, .382, .066
Violator Initiated War?	-.909, .208, <.001
Violator Battle Death Rate	-.335, .087, <.001
Violator Lost	.608, 431, n.s.
Violator Lost times Power Ratio	-1.785, .766, .020

Constant	7.790
N	1248
Log Likelihood	-1488.6
χ^2	465.2 w 21 d.f.s
Significance Probability of Model	<.0001

Each cell gives estimated coefficient, standard error, and significance for a two-tailed test that the coefficient is different from 0 if the statistical significance exceeds the .1 level.

The omitted category for the dummy variables of the issue-areas is treatment of the wounded.

Footnotes for Chapter 4'

1. Internment of civilians is classified as a major violation except when it is absolutely necessary. Detention of enemy civilians at the outbreak of war, except for military personnel or security risks is a minor violation.

2. In order to be lawful, a naval blockade has to be formally declared and effective; that is, it has to be properly enforced by warships of the blockading State.

3. Data on state signings, ratifications, and reservations to these treaties can be found at http://www.icrc.org/web/eng/siteeng0.nsf/iwpList2/Info_resources:IHL_databases, which was used to code these variables.

4. The database on International Humanitarian Law compiled by the ICRC only records the existence of state reservations to treaties and not their precise content.

5. Capabilities and distance data were obtained from EUGene version 3.04 ({Bennett, 2000 #489}).

6. It would be more accurate to describe the variable as non-compliance because higher values represent less compliance with existing treaties or norms. However, it is easier to say compliance, and I will do so throughout this chapter. I will frequently remind the reader that higher values means worse violations and hence less compliance.

7. I have also conducted analyses using three and five point scales of compliance. Those results can be found at the website.

8. There are dyadic wars when neither side is considered the initiator, such as dyadic wars that arise from the intervention of a state into an ongoing war. Hence, there are more cases in the analysis without initiators than the analysis of only initiators.

9. Analyses that use joint ratification in place of whether the violator had ratified produce similar results. See the webpage for these.

10. Individual level violations score 2 or 3 on the centralization variable, while state violations score 4 or 5.

11. These variables are the parallel of the included exogenous variables for the victim, such as its democracy score.

12. This test is whether the sum of the coefficient for joint ratification and power ratio times the interaction of power ratio and joint ratification is different from 0. I set power ratio to its mean of .5 for the test. The difference between the violator not ratifying and joint ratification, the sum of these two terms and violator ratified, is statistically significant at the .001 level.

13. We should not read too much into the better baseline compliance under joint ratification. It is consistent with deterrence through reciprocity. The coefficients in Table 4'.6 do not include the effects of reciprocity which is part of the effect of joint ratification. Returning to Figure 4.3, there is little visible difference in compliance behavior between joint ratification and not when the victim

fully complies. The visible trace of deterrence through reciprocity is the lower chance of low or noncompliance when the victim has high compliance.

14. An estimation fitting a Weibull distribution to the data provides similar results.