

A Unified Theory and Test of Extended Immediate Deterrence

Curtis S. Signorino
Ahmer Tarar*
University of Rochester

Work in progress
Comments welcome

November 16, 2000

Abstract

We present a unified theory and test of extended immediate deterrence — unified in the sense that we employ our theoretical deterrence model as our statistical model in the empirical analysis. The theoretical model is a straightforward formalization of the extended immediate deterrence logic in Huth (1988), coupled with private information concerning utilities. Contrary to Huth (1988), our empirical analysis suggests that nuclear weapons, military alliances, military arms transfers, and foreign trade all affect deterrence success. Our model correctly predicts almost 97% of the potential attacker's actions and over 91% of the crisis outcomes. Finally, we find strong evidence that the likelihood of deterrence success and of war are not monotonically related to the variables involved in the deterrence calculus. This contradicts a fundamental assumption of most previous studies.

*Department of Political Science, University of Rochester, Rochester, NY 14627. Email: sign@troi.cc.rochester.edu, ahmt@troi.cc.rochester.edu. Paper presented at the 2000 annual meetings of the American Political Science Association, the Midwest Political Science Association, and the Peace Science Society International. Our thanks to Stuart Bremer, Stephen Gent, Paul Huth, Kris Ramsey, Branislav Slantchev, Alan Stam, and Robert Walker for their helpful comments, to Kris Ramsey, Dustin Tingley, and Kuzey Yilmaz for their research assistance, and to Paul Huth for providing his data. Support from the National Science Foundation (Grant # SES-9817947) is gratefully acknowledged.

Contents

| | | |
|----------|---|-----------|
| 1 | Introduction | 3 |
| 2 | A Strategic Model of Extended Immediate Deterrence | 4 |
| 2.1 | Uncertainty Concerning Utilities | 5 |
| 3 | Empirical Analysis | 8 |
| 3.1 | Variables and Data | 10 |
| 3.2 | Strategic Probit Analysis | 12 |
| 3.3 | Factors that Affect Deterrence Actions and Outcomes | 14 |
| 3.3.1 | The Defender's Utility for War | 14 |
| 3.3.2 | The Attacker's Utilities | 15 |
| 3.3.3 | The Probability of Deterrence Success and of War | 16 |
| 3.4 | Model Fit | 23 |
| 4 | Concluding Remarks | 24 |

1 Introduction

The deterrence literature is one of the most exhaustive in international relations. The logic of deterrence has been extensively studied both within the government and academia by scholars from a variety of disciplines.¹ The logic is continuously put under the microscope of rigorous empirical testing, and subsequently refined. It is no wonder, then, that even the informal rational deterrence literature tends to be transparent in its logic, with much attention paid to the sequencing of moves and to the incentives and expected behavior of other states.

Recent research by Signorino (1999) and Signorino and Yilmaz (2000), however, shows that previous empirical tests of deterrence theories are highly problematic. The heart of the problem is that deterrence is generally considered to be a strategic interaction, but is empirically investigated using non-strategic statistical models such as logit and probit. Signorino (1999) demonstrates how failure to incorporate strategic interaction into statistical tests results in faulty inferences. Signorino and Yilmaz (2000) show that using logit to analyze data generated by strategic interaction induces the equivalent of omitted variable bias.² The upshot of this recent methodological research is that a statistical model needs to be structurally consistent with the theory it is testing. Strategic models imply a particular structural relationship between the regressors and the dependent variable. Typical logit and probit models imply a different structural relationship.

In this study, we present the first unified theory and test of extended immediate deterrence — unified in the sense that we employ our theoretical deterrence model as our statistical model in the empirical analysis. The theoretical model is a straightforward formalization of the extended immediate deterrence logic in Huth (1988), coupled with private information concerning utilities. We construct our deterrence model in such a way that it guarantees positive probabilities over all actions and outcomes and, therefore, can be used in statistical estimation. In other words, our theoretical model *is* our statistical model.

We then put this model under the empirical microscope, using data from Huth (1988) and Huth and Russett (1988). Contrary to Huth (1988), our empirical analysis suggests that nuclear weapons, military alliances, military arms transfers, and foreign trade all affect deterrence success. Moreover, in terms of model fit, our model correctly predicts (actually, postdicts) almost 97% of the potential attacker's actions and over 91% of the crisis outcomes. Finally, we find strong evidence that the likelihood of deterrence success and of war are not monotonically related to the variables involved in the deterrence calculus. This contradicts a fundamental structural assumption of previous studies

¹For a collection of articles that survey the diverse array of approaches that have been used to study deterrence, see Stern, Axelrod, Jervis, and Radner (eds.) 1989.

²In fact, the simple model employed in Signorino and Yilmaz (2000) has the same form as the deterrence model analyzed here.

using logit and probit.

By way of a roadmap, in the next section we present our theoretical model, which is a straightforward formalization of some of the extended immediate deterrence literature, coupled with private information concerning payoffs. Following that, we specify the utilities of the model in terms of regressors. Using data from two previous studies of extended immediate deterrence, we then conduct our empirical analysis. We discuss the factors that influence deterrence success and the decision to go to war, and assess model fit. We conclude by summarizing the results and noting possible avenues for future research.

2 A Strategic Model of Extended Immediate Deterrence

A distinct advantage of the relatively transparent rational deterrence logic is that it allows for straightforward translation into a formal model. An excellent example is the literature on extended immediate deterrence (Huth 1988, 1990; Huth and Russett 1988). In extended immediate deterrence, a “defender” nation is trying to deter a potential aggressor from attacking one of its allies or “proteges.” Henceforth, we will refer to the defending nation simply as the “defender,” the potential aggressor as the “attacker,” and the defender’s ally or protege that is being threatened simply as the “protege.” The deterrence situation is considered “extended” in that the defender is trying to deter an attack on a third nation rather than on itself, and “immediate” in that the attacker has made threats and the defender counterthreats, so that the deterrence attempt takes place in a crisis atmosphere in which the use of force may be imminent (for the distinction between “immediate” and “general” deterrence, see Morgan 1977, 31-43). Of primary interest in this literature is the interaction between the attacker and the defender.

Figure 1 displays this interaction in the form of a simple extensive form game. Here, the (potential) attacker can either attack (A) or not attack (\bar{A}). If the attacker chooses not to attack, the deterrence success results in a status quo (SQ) outcome. If, on the other hand, the attacker chooses to attack, deterrence has clearly failed, and the defender must decide whether to come to the aid of its protege. If the defender chooses to defend (D) against the attacker, war (War) results. If the defender does not defend (\bar{D}) its protege, then we regard the defender as having capitulated (Cap).

It is certainly true that more complicated formal deterrence models have been developed than that depicted in Figure 1 (see, for instance, Fearon 1994; Kilgour and Zagare 1991; Kugler and Zagare 1987; Powell 1990; Werner 2000; Zagare and Kilgour 1993). However, we employ this model for a number of reasons. First, we believe that it most closely represents the logic of the extended immediate deterrence literature (Huth 1988, 1990; Huth and Russett 1988, 1993).

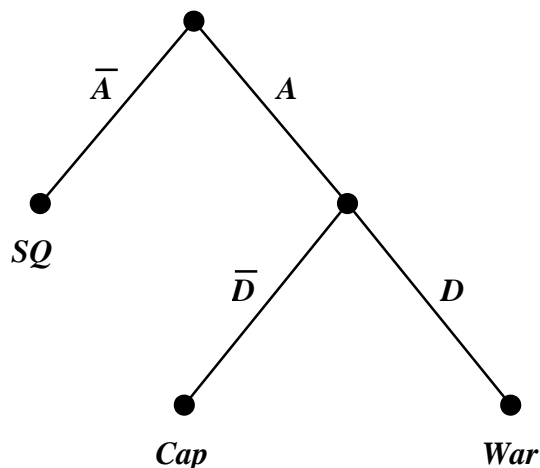


Figure 1: An Extended Immediate Deterrence Model. *Here, a (potential) attacker must decide whether to use force against the defender’s protege. If deterrence succeeds and the attacker does not attack (\bar{A}), the status quo (SQ) results. If deterrence fails and the attacker attacks the protege, then the defender must decide whether to aid its protege. Defending against the attacker results in war (War). Not defending results in capitulation (Cap).*

Second, not only has this literature undertaken rigorous empirical testing, but data exists for testing the model presented in Figure 1. This is not a trivial issue, given that most data collection in international relations (and political science more generally) has been undertaken without regard to the predictions of formal models. Third, given that this study represents the first example of a unified theory and test of deterrence, we prefer to begin with a simple model rather than a more complex one. Achen and Snidal (1989, 151) verbally describe this model, calling it “the simplest version of rational deterrence theory.”³ As we will demonstrate in Section 3.2, this simple model appears to go a long way in explaining extended immediate deterrence outcomes. However, before proceeding to the empirical analysis, we must further specify the model.

2.1 Uncertainty Concerning Utilities

It is unlikely that the participants of a deterrence crisis (or almost any situation, for that matter) perfectly observe each other’s utilities. It is also unlikely that the analyst, in conducting the empirical analysis, can perfectly specify the actors’ utilities. Fortunately, relaxing this assumption not only provides a model that is more satisfying theoretically, but also one that can be used as the basis of our statistical estimation.

Figure 2 displays the same strategic situation as in Figure 1, but assumes that the attacker and

³Zagare and Kilgour (2000) also briefly describe this model.

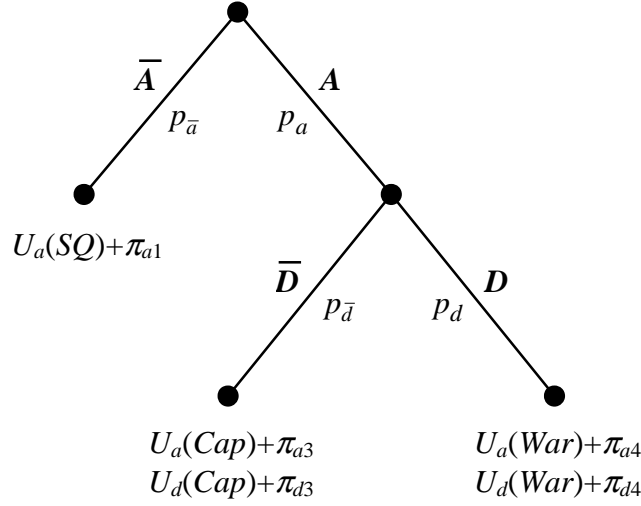


Figure 2: The Deterrence Model with Uncertainty Concerning Utilities. *The utilities shown in the figure represent each player's true utilities, broken into their observable $U_i(\cdot)$ and unobservable π_{ij} components. For example, let the defender's true utility for war be written as $U_d^*(War) = U_d(War) + \pi_{d4}$. The attacker observes $U_d(War)$, but knows only the distribution of the unobserved π_{d4} . We assume that the analyst also does not observe the π_{ij} .*

defender do not perfectly observe each other's utilities. We also assume that the analyst does not perfectly observe the actors' utilities. Instead, we assume that the true utility for an outcome can be represented as consisting of an observable component and an unobservable (or private) component. For example, let the defender's utility for war be represented as

$$U_d^*(War) = U_d(War) + \pi_{d4}$$

where $U_d^*(War)$ is the defender's true utility for war, $U_d(War)$ is the component of the true utility that the attacker and the analyst observe, and π_{d4} is the component that is private information to the defender. From the attacker's and analyst's perspective, π_{d4} is a random variable. We will assume that the attacker and the analyst know only the distribution of π_{d4} .

If, as depicted in Figure 2, we make this assumption concerning each of the players' utilities, we can derive equilibrium choice probabilities for each of the actions and outcomes in the game (see Signorino 2000 for details on deriving the choice probabilities of various strategic probit models). Let us assume that the payoff perturbations (i.e., the π_{ij} s) are independently and identically distributed $N(0, \sigma^2)$. Let p_d denote the probability that the defender defends the protege and p_a denote the probability that the attacker attacks the protege. Conversely, let $p_{\bar{d}}$ and $p_{\bar{a}}$ denote the probabilities that the defender does not defend and that the attacker does not attack, respectively. Assuming that the actors maximize their true utility at their decision nodes, the strategic probit

choice probabilities for the deterrence model in Figure 2 are easily derived as

$$p_d = \Phi \left[\frac{U_d(War) - U_d(Cap)}{\sqrt{2\sigma^2}} \right] \quad (1)$$

$$p_a = \Phi \left[\frac{p_d U_a(War) + p_{\bar{d}} U_a(Cap) - U_a(SQ)}{\sqrt{\sigma^2 (p_d^2 + p_{\bar{d}}^2 + 1)}} \right] \quad (2)$$

where $\Phi(\cdot)$ is the standard Normal cumulative distribution function, and where $p_{\bar{d}} = 1 - p_d$ and $p_{\bar{a}} = 1 - p_a$.

Notice that the equilibrium choice probabilities reflect the extended immediate deterrence logic of the extensive form game and the uncertainty of the players concerning each other's payoffs. The numerators of Equations 1 and 2 express the difference in observed expected utility for the options associated with each decision node. For example, the probability p_d that the defender aids its protege is a function of the difference in its observed utility for war relative to capitulation: the higher the defender's observed utility for war relative to capitulation, the higher the probability that the defender will defend its protege.

Similarly, the numerator of Equation 2 is a function of the attacker's observed expected utility for attacking relative to its observed utility for not attacking. The attacker's observed expected utility for attacking is a lottery over the capitulation and war outcomes, based on its belief p_d about whether the defender will defend its protege: $EU_a(A) = p_d U_a(War) + p_{\bar{d}} U_a(Cap)$. The higher the attacker's observed expected utility for attacking relative to the status quo, the less likely the attacker will be deterred.

The denominator of each probability equation is a variance term, reflecting the amount of uncertainty concerning the unobserved component of the true utilities. A large σ^2 relative to the observable components reflects greater uncertainty on the part of the actors and the analyst, resulting in strategic choice probabilities closer to a coin toss over the options. When the players and the analyst have more accurate information about the true utilities — i.e., when σ^2 is small — the choice probabilities approach 0 and 1, and the deterrence model in Figure 2 approaches that of a game of perfect and complete information. Note that when $\sigma^2 = 0$, the game is exactly one of perfect and complete information, and our assumption that states maximize their utility at each decision node implies subgame perfection.

It should also be noted that Equations 1 and 2 do not represent mixed strategies. Rather, they are the beliefs of the attacker and the analyst, based on their assumptions of utility maximizing behavior, uncertainty concerning the π_{ij} , and the structure of the game. p_d is the belief of both the attacker and the analyst about whether the defender will fight. p_a represents the analyst's belief about whether the attacker will attack, given the attacker's (and analyst's) belief about whether

the defender will defend. Except in a few knife-edge situations, the underlying behavioral model assumes that the attacker and the defender play pure strategies *from their perspective*.⁴ The twist (relative to conventional game theory) is that the *empirical* analyst is assumed to know only the distribution of the π_{ij} . Therefore, the analyst can only make probabilistic statements about the equilibrium choices.

With that said, the equilibrium outcome probabilities follow directly from the action probabilities. Let p_{sq} , p_{cap} , and p_{war} be the probabilities of the status quo, capitulation, and war outcomes, respectively. Because of the independence assumption, the probability of any given outcome is the product of the action probabilities along its path. Hence,

$$p_{sq} = p_{\bar{a}} \tag{3}$$

$$p_{cap} = p_a p_{\bar{d}} \tag{4}$$

$$p_{war} = p_a p_d \tag{5}$$

We now have a strategic deterrence model that is also a statistical (i.e., probabilistic) model. As long as there is some uncertainty concerning the true utilities (on the part of the states and the analyst), we are guaranteed positive probabilities over all actions and all outcomes in the model, and we can use this theoretical model directly in our statistical estimation. In doing so, the deterrence theory and its test are unified.

3 Empirical Analysis

The typical empirical analysis, not only in the deterrence literature but in much of the international relations literature, begins with a list of hypotheses drawn from extant theory. In these cases, the hypotheses to be tested almost invariably involve unconditionally monotonic relationships between the dependent variable and the regressors.⁵ In the current context, an example of such a hypothesis would be

H: The likelihood of war decreases as the balance of forces increasingly favors the defender.

As Signorino and Yilmaz (2000) show, even the simplest strategic model often implies nonmonotonic — or at least only conditionally monotonic — relationships between the dependent variable and the regressors.⁶ That our strategic theories often imply nonmonotonic or conditionally monotonic

⁴The attacker chooses D if and only if $U_a^*(War) > U_a^*(Cap)$. The attacker chooses A if and only if $p_d U_a^*(War) + p_{\bar{d}} U_a^*(Cap) > U_a^*(SQ)$.

⁵There are simply too many examples to cite. For some of the better empirical analyses along these lines, see Huth 1988; Huth, Gelpi, and Bennett 1993.

⁶The relationship in the above hypothesis is *monotonic* because it implies that as we increase the value of the explanatory variable, the dependent variable always decreases (or always increases), holding all other variables constant. The hypothesis is also *unconditionally monotonic* because it is assumed that the monotonicity and its direction

relationships suggests that typical hypothesis statements are problematic, especially when there is no clear link from the hypothesis to a well-specified model.⁷ Because of that and because we have a statistical model that is also our theoretical model, we take a slightly different approach here.

In conducting hypothesis tests, we are usually interested in assessing whether some substantive variable has an effect on the the phenomenon of interest. In the present context, we might hypothesize that the balance of military forces or the defender’s possession of nuclear weapons affect the attacker’s decision to attack. Alternatively, we might hypothesize that other variables, such as past crisis behavior or current bargaining behavior, contribute to deterrence success (Huth 1988). Finally, in addition to the effects of particular variables, we may want to assess how well a model explains deterrence outcomes where the model includes everything from the game structure to the included regressors. All of this can be accomplished using the statistical strategic deterrence model derived above and the relevant regressors.

Deciding which variables enter each of the utilities in the game and how to estimate the parameters associated with those variables are not trivial matters. Ideally, theory should be the guide, not only for the structure of the interaction, but also for the specification of the utilities. In a perfect world, we would have variables representing the “primitives” of state preferences. Indeed, the functional form of the utility equations should also be theoretically justified. With little else to go on, our approach is to specify the set of utilities for a player as simply as possible and with an eye towards differences in utilities, since it is the size of the utilities *relative* to each other that determine the equilibrium choice probabilities.

Figure 3 shows the general specification of the utilities employed in the subsequent data analysis. Here, the attacker’s observed utility for the status quo is a linear function $X_{11}\beta_{11}$ of explanatory variables, where β_{11} is a vector of parameters to be estimated, its observed utility for capitulation is estimated as a constant β_{130} , and its observed utility for war is a linear function $X_{14}\beta_{14}$ of explanatory variables. In this manner, we are able to differentiate the attacker’s utility for war from his utility for capitulation, and his utility for attacking from his utility for not attacking (i.e., the status quo).⁸ The defender’s utility for capitulation is normalized to zero and we treat her utility for war as a function $X_{24}\beta_{24}$ of explanatory variables.⁹

hold for every possible set of values at which the other variables could be held constant. *Conditional monotonicity* implies monotonicity for every set of values at which the other variables are held, but allows the direction of that monotonic relationship to differ, depending on the values at which the other variables are held.

⁷We are not suggesting that hypothesis testing as a method of inference is problematic, only the (typical) listing of unconditionally monotonic hypotheses with no clear (i.e., derivable) link to a strategic model.

⁸One need not necessarily estimate a constant for the attacker’s utility for the capitulation outcome. If variables different than those in X_{14} were available — and were theoretically justified — one could estimate $X_{13}\beta_{13}$. However, using the same variables in the utility equation for capitulation as in the equation for war would create an identification problem.

⁹The defender’s utility for the status quo does not affect the choice probabilities p_d and p_a , which is why we do not provide a specification for it.

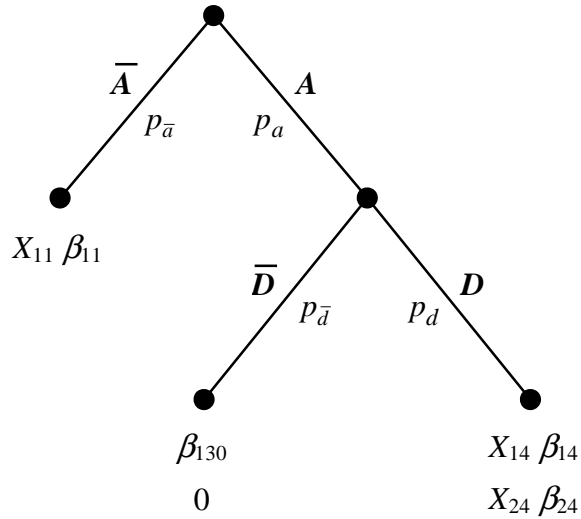


Figure 3: Specification of the Attacker’s and Defender’s Utilities in Terms of Regressors. *The figure displays the specification of the observable components of the utilities in terms of regressors. (To simplify the presentation, we have dropped the private π_{ij} components.) The attacker’s utility for the status quo is a function $X_{11}\beta_{11}$ of explanatory variables, its utility for capitulation is estimated as a constant β_{130} , and its utility for war is a function $X_{14}\beta_{14}$ of explanatory variables. The defender’s utility for capitulation is normalized to zero and its utility for war is a function $X_{24}\beta_{24}$ of explanatory variables.*

The estimation method we employ is detailed in Signorino (2000). The strategic outcome probabilities in Equations 3–5 are used as the basis of maximum likelihood estimation. Let $y_{sq,i} = 1$ if the crisis in observation i results in a status quo outcome, and zero otherwise. Let $y_{cap,i} = 1$ if the crisis results in capitulation by the defender, and zero otherwise. Let $y_{war,i} = 1$ if the crisis results in war between the attacker and the defender, and zero otherwise. The log-likelihood to be maximized (with respect to the β s) is

$$\ln L = \sum_{i=1}^N [y_{sq,i} \ln p_{sq,i} + y_{cap,i} \ln p_{cap,i} + y_{war,i} \ln p_{war,i}] \quad (6)$$

Finally, one generally cannot estimate the effects parameters (i.e., the β s) and the variance parameter σ individually. As with most other discrete choice models, they are not all individually identified given the model and the data. As in standard (i.e., nonstrategic) probit estimation, we normalize σ^2 to one. Parameter estimates are therefore actually estimates of the β s and σ to scale.

3.1 Variables and Data

We are fortunate in that data is available both on the outcomes of our model and on many substantively interesting factors often hypothesized to affect extended immediate deterrence. The bulk

of the data used here is from the previous studies of Huth (1988) and Huth and Russett (1988), which examine fifty-eight extended immediate deterrence crises from 1885 to 1983.

The dependent variable in this study codes which of the outcomes $\{SQ, Cap, War\}$ occurred in each of the fifty-eight crises. In the context of our model, the dependent variable examined in Huth (1988) codes whether the attacker attacked or not, A vs \bar{A} , respectively. Huth and Russett (1988) followed Huth (1988) with an analysis of the defender's actions in those twenty-four cases in which the attacker attacked. In the context of our model, Huth and Russett (1988) provide data on whether the defender defended or not, D versus \bar{D} , given that the attacker used force against the protege. The sequence of actions coded in these two studies match the actions in our deterrence model and, therefore, provide all the information we need to code the outcome for each observation.

Almost all of our explanatory variables are drawn from Huth (1988). Rather than repeat their operationalizations, we refer the reader to Huth (1988) for the complete details. In general, they can be grouped under the following headings:

Balance of Forces: Whether the defender possessed nuclear weapons (*NUCLEAR*). The immediate balance of forces (*IBF*) as a ratio of the defender-protege to the attacker — i.e., $IBF > 1$ implies a stronger defender-protege, and $IBF < 1$ implies a stronger attacker. The short-term balance of forces (*SBF*). The long-term balance of forces (*LBF*).¹⁰

Defender's Interests at Stake: Whether the defender and protege had an alliance (*MILALL*). The share of the protege's arms imports that come from the defender (*MILARM*), scaled from 1–10. The protege's share of the defender's total merchandise imports and exports (*FORTRADE*), scaled from 0–10.

Defender's Reputation from its Last Crisis: Whether the defender successfully deterred an opponent in its last crisis (*PASTDET*). Whether the defender came to its protege's aid in its last crisis, if the opponent was not deterred (*ARMED*). Whether the defender capitulated in its last crisis, if the opponent was not deterred (*CAPITU*). All three of these variables equal zero when the defender has never been in an extended immediate deterrence situation before.

¹⁰ *IBF* is measured as the ratio of the defender-protege ground troops to the potential attacker's ground troops, including only those troops that are at forward positions and that can be deployed to the scene of the battle immediately. *SBF* includes each side's standing ground and air forces and first class of trained reserves; it measures each side's ability to reinforce the troops that are deployed at or near the scene of the battle, as measured by *IBF*. Huth (1988, 61-2) defines *LBF* as "the capacity of the defender and protege and the potential attacker to build up their existing armed forces (army, air, and naval manpower) and to maintain an increased level of fighting strength by mobilizing the economy and civilian population for war . . . Each state's existing military capabilities (percentage share of world military personnel and military expenditures) were multiplied by the sum of that state's industrial and demographic resources (percentage share of world steel production, industrial fuel consumption, urban, and total population). The ratio of defender's and protege's capabilities to potential attacker's capabilities was then calculated." Data comes from the Correlates of War National Capabilities Data Set.

Defender’s Reputation from its Last Crisis, if any, with the Current Attacker: Whether the defender adopted a bullying strategy or forced the attacker to make critical concessions in order to avoid armed conflict, or both (*PUTDOWN*). Whether the defender and attacker avoided a military confrontation, but failed to resolve the underlying issues of the dispute (*STALEMATE*). Whether the defender retreated under diplomatic and/or military pressure from the attacker in order to avoid military conflict (*DIPLO*). All three of these variables equal zero if the attacker and defender have never been in a crisis before.

Defender’s Bargaining Behavior in the Current Crisis: Whether the defender has adopted a “firm-but-flexible” strategy in diplomatic negotiations until now (*FIRMFLEX*). Whether the defender has responded proportionally to the military moves of the attacker (*TFT*).

Others: Whether the attacker and defender are territorially contiguous (*CONTIGAD*).¹¹ Whether the attacker and protege are contiguous (*CONTIGAP*). Whether the defender and protege are contiguous (*CONTIGDP*). We also include a variable (*SYEAR*) that controls for trends over time. It simply indexes the date of the crisis in the data set. *SYEAR* is coded as the calendar year minus 1885, which is the earliest calendar year in the data.¹²

3.2 Strategic Probit Analysis

Table 1 displays the results of the strategic probit regression. We found that the variables representing the defender’s reputation from past crises were not significant, nor were attacker–defender and attacker–protege contiguity. Finally, *FIRMFLEX* was also not significant. Table 1 displays the coefficients of the remaining variables. The four columns report the maximum likelihood estimates of the coefficients associated with the variables entering into the defender’s utility for war ($\hat{\beta}_{24}$), the attacker’s utility for war ($\hat{\beta}_{14}$), the attacker’s utility for the status quo ($\hat{\beta}_{11}$), and the attacker’s utility for the defender’s capitulation ($\hat{\beta}_{130}$), respectively. Standard errors are shown below the estimates. Estimates with one asterisk are statistically significant at $p < .10$ (two-tailed). Estimates with two asterisks are significant at $p < .05$. Finally, the mean log-likelihood, the percent of outcomes (war, status quo, or capitulation) correctly predicted (actually, postdicted), and the percent of the attacker’s actions (attack or not attack) correctly predicted are displayed at the bottom to provide a sense of how well the model fares. In contrast to Huth (1988), the results suggest that nuclear weapons have an impact on deterrence success, as do military alliances, military arms transfers, and foreign trade. The model correctly predicts almost 97% of the attacker’s actions and over 91% of the outcomes.

¹¹We use strict land contiguity. Thus, for instance, we don’t consider Turkey and Cyprus to be contiguous.

¹²Using the raw calendar year causes numerical problems in the estimation, because the magnitude of the calendar year is much larger than that of the other explanatory variables.

| | U _d (War) | U _a (War) | U _a (SQ) | U _a (Cap) |
|---------------------|-----------------------|------------------------|----------------------|----------------------|
| $\hat{\beta}_{130}$ | | | | 330.61 841.5 |
| Nuclear | 6.62** 2.96 | -2.72 2.96 | | |
| Immediate Balance | 5.88** 2.44 | -0.44 .41 | | |
| Short-term Balance | 1.28** .75 | -3.37** 2.04 | | |
| Long-term Balance | .15 .51 | 1.15** .70 | | |
| Military Alliance | -5.2** 2.64 | -8.29* 6.4 | | |
| Arms Transfers | .55* .39 | -1.15 .19 | | |
| Foreign Trade | 4.0** 1.3 | | -.74** .38 | |
| Tit-for-Tat | | | 1.94* 1.36 | |
| Year (scaled) | -.15** .06 | .04 .04 | | |
| Def-Pr Contiguity | 5.97** 2.87 | | | |
| Mean lnL | -234 | | | |
| PCP Outcomes | 91.37 | | | |
| PCP Deter | 96.55 | | | |

Standard errors are shown below parameter estimates.
N=58. ** $p < .05$. * $p < .10$. (two-tailed)

Table 1: Data Analysis of Strategic Deterrence Model. *The table displays the results of the strategic probit regression based on the model in Figure 3. The four columns report the maximum likelihood estimates of the coefficients associated with the variables entering into the defender's utility for war ($\hat{\beta}_{24}$), the attacker's utility for war ($\hat{\beta}_{14}$), the attacker's utility for the status quo ($\hat{\beta}_{11}$), and the attacker's utility for the defender's capitulation ($\hat{\beta}_{130}$), respectively. In contrast to Huth (1988), the results suggest that nuclear weapons have an impact on deterrence success, as do military alliances, military arms transfers, and foreign trade. The model correctly predicts almost 97% of the attacker's actions and over 91% of the outcomes.*

3.3 Factors that Affect Deterrence Actions and Outcomes

3.3.1 The Defender's Utility for War

In this section, we examine the parameter estimates for the defender's utility for war. The first column of Table 1 shows that every variable in the defender's utility except *LBF* and *MILARM* (arms transfers) is statistically significant at $p < .05$, and *MILARM* is significant at $p < .10$. Possession of nuclear weapons, immediate and short-term balance of forces favoring the defender-protege, higher levels of military arms transfers from the defender to the protege, higher levels of trade between the defender and the protege, and contiguity between the defender and the protege all increase the likelihood that the defender will fight to defend the protege. All of these results fit with a "common sense" intuition of what should affect crisis behavior.

Somewhat puzzling is the result concerning whether a military alliance exists between the defender and the protege. The negative coefficient for the military alliance variable indicates that if a military alliance exists between the defender and the protege, the former is *less* likely to come to the latter's aid. One conjecture would be that this is a selection issue. The presence of a military alliance is an *ex ante* indicator of the defender's interest in protecting the protege (Fearon 1994). Therefore, we would expect that the presence of a military alliance would be associated with *general* deterrence success (other things being equal, a potential attacker is less likely to challenge a protege that is under the formal protection of a defender than one that is not). It may be that when there is a formal military alliance between the defender and the protege, potential attackers only challenge the protege (resulting in general deterrence failure) when they believe that the alliance is a bluff, i.e. that it will not be honored. If that is the case, and if the potential attackers are generally accurate in their assessments, then in the sample of cases in which general deterrence failed (which is exactly the sample of cases in the data set analyzed here), the defender's decision to protect its protege will be *negatively* associated with the presence of a military alliance. Indeed, that is what we observe here.¹³

Finally, the results indicate that the defender's utility for war decreases over time, or at least over the period analyzed in the data. Further research would be required to explain this trend. However, the increasing role of the media and increasing democratization might plausibly produce this effect. The increasing moral approbation towards colonialism may also play a role (potential defenders are less likely over time to fight to protect former colonies).

¹³For "selection effect" explanations of the non-intuitive empirical relationship between the presence of a military alliance and extended immediate deterrence success (rather than the defender's decision to defend or not, given that the attacker has attacked, which is what we have just discussed), see Huth and Russett 1984, 517; Fearon 1994; Huth and Russett 1993, 62.

3.3.2 The Attacker's Utilities

Now consider the attacker's utility for the status quo (the third column of Table 1). Tit-for-tat, or proportional responses by the defender to the attacker's military preparations in the current crisis increases the attacker's utility for the status-quo. This is consistent with Huth (1988), who argues that tit-for-tat bargaining indicates that the defender is resolved to defend the protege, but does not provoke the attacker by putting his reputation and credibility on the line, as a more aggressive/bullying bargaining strategy by the defender might. It is interesting to note that *TFT* is not a statistically significant component of the the defender's utility for war. That is, even though tit-for-tat bargaining by the defender increases the attacker's utility for the status-quo relative to attacking the protege, tit-for-bargaining does not increase the likelihood that the defender actually *will* go to war to defend the protege. That is, tit-for-tat bargaining appears to be an effective signaling device, but a bluff.¹⁴ This interesting finding merits further investigation.

Increased foreign trade between the defender and the protege decreases the attacker's utility for the status quo relative to attacking the protege. This suggests that more economically active proteges may be more appealing targets, and that attackers are willing to attack more economically active proteges even though defenders are more likely to fight to defend them (more on this later).

Now consider the attacker's utility for war. The second column of Table 1 shows that a defender-protege advantage in short-term balance of forces and a defender-protege military alliance both decrease the attacker's utility for war relative to the other outcomes.¹⁵ These results seem intuitive. Note that the finding that the presence of a military alliance decreases the attacker's utility for war is not contradictory to our "selection effect" argument above. The selection effect argument was that when there is a formal military alliance between the defender and the protege, the potential attacker will generally challenge the protege only if it believes that the alliance is a bluff. If a military alliance increases the effectiveness with which the defender and the protege fight together (perhaps because their militaries have been training together; Morrow 1994, 1999), then the presence of a military alliance will decrease the attacker's utility for war relative to the other outcomes even in this self-selected sample. That is, even in a sample in which alliances are generally believed to be non-credible, attackers will be better off fighting two states whose militaries have not effectively trained together than two whose militaries have. Lastly, Table 1 indicates that a higher defender-protege advantage in long-term balance of forces increases the attacker's utility for war. It is not clear why this would be the case. This could be representative of a selection issue. It could also be an artifact of only having 58 observations. Regardless, it merits further investigation.

¹⁴Of course, it is important to note that we only have 58 observations, and this may be responsible for the insignificance of *TFT* in the defender's utility for war.

¹⁵To be precise, they decrease our expectation of the attacker's true utility — i.e., they decrease the observable component.

Finally, we have placed no constraints on the signs of the parameters estimated or on the preference orderings implied by the estimates. There may indeed be cases where a state is simply looking to pick a fight. However, we usually assume that states prefer to achieve their (other) goals without paying war costs. In terms of our model, it would seem reasonable to assume that the attacker always prefers that the defender capitulate rather than go to war — i.e., that $U_a(War) < U_a(Cap)$. If this is true and if our model is appropriately specified, we should expect the attacker’s estimated utility for war $\hat{U}_a(War)$ to generally be less than its estimated utility for capitulation, $\hat{U}_a(Cap) = \hat{\beta}_{130}$.

Table 1 provides the attacker’s estimated utility for capitulation: $\hat{U}_a(Cap) = \hat{\beta}_{130} = 330.6$. To assess whether the attacker’s estimated utility for war is above or below this, we simply estimated the maximum it could be based on the data. Note that the attacker’s estimated utility for war is calculated by $\hat{U}_a(War) = X_{14}\hat{\beta}_{14}$. To determine the maximum utility for war $\hat{U}_a^{\max}(War)$, we set the variables in X_{14} to the values realized in the data that would maximize this utility. Based on the data, the maximum estimated utility for war is $\hat{U}_a^{\max}(War) = 11.2$, which is much less than $\hat{U}_a(Cap) = 330.6$. Although $\hat{\beta}_{130}$ is not significant by conventional standards (in this case, $p = .34$), it is reassuring to note that it makes sense in the context of the model, especially given that we did not constrain the estimation — i.e., force it to “make sense.”

3.3.3 The Probability of Deterrence Success and of War

As in other discrete choice models (such as multinomial logit or probit), interpreting the relationship between the dependent and independent variables simply by examining the regression results is difficult. A better means for assessing those relationships is to determine how predicted probabilities change as the values of the explanatory variables change. One advantage of our strategic probit analysis is that we can assess the impact of the explanatory variables not only on the probability of deterrence success (to which Huth 1988 is limited), but also to any of the other actions and outcomes of the model. In addition to examining the effects of the explanatory variables on the probability of deterrence success ($p_{\bar{a}}$), we will also analyze their impact on the probability of war between the attacker and the defender (p_{war}). For both of these, we use the equilibrium probabilities in Equations 1–5 and the estimates reported in Table 1.

Before proceeding, we should note that in the context of our deterrence model, relevant variables can affect the attacker’s behavior in two ways: *directly* through its utility for the various outcomes and *indirectly* through the probability p_d that the defender defends. The attacker attacks if and only if its true expected utility for attacking is greater than its true utility for the status quo; i.e., if and only if $p_d U_a^*(War) + p_{\bar{d}} U_a^*(Cap) > U_a^*(SQ)$. p_d is a function of the explanatory variables in the defender’s utility for war, X_{24} (Equation 1). Hence, those variables affect not only the defender’s

| | Min | Mean ₀ | Mean | Mean ₁ | Max |
|--------------------|-----|-------------------|------|-------------------|------|
| Nuclear | 0 | 0 | 0 | 1 | 1 |
| Immediate Balance | .12 | 1.24 | 1.24 | 1.24 | 5.56 |
| Short-term Balance | .06 | 1.19 | 1.19 | 1.19 | 5.8 |
| Long-term Balance | .01 | 1.96 | 1.96 | 1.96 | 6.69 |
| Military Alliance | 0 | 0 | 0 | 1 | 1 |
| Arms Transfers | 1 | 5.1 | 5.1 | 5.1 | 10 |
| Foreign Trade | 0 | 1.74 | 1.74 | 1.74 | 9.5 |
| Tit-for-Tat | 0 | 0 | 1 | 1 | 1 |
| Year (scaled) | 0 | 49.2 | 49.2 | 49.2 | 98 |
| Def-Pr Contiguity | 0 | 0 | 0 | 1 | 1 |

Table 2: Minimum, Mean/Median, and Maximum Values of Explanatory Variables.

decision to defend, but also the attacker’s decision to attack, albeit indirectly, through p_d . In other words, variables that are statistically significant in the defender’s utility for war but not in the attacker’s utilities, such as *NUCLEAR* and *IBF*, still affect the attacker’s decision to attack or not.

It is typical in analyses of fitted values or first differences to hold “all other variables” (i.e., other than the one being varied) constant at some value, usually their means. However, four of the explanatory variables in Table 1 are binary, and their means are values we would never observe in the data. Moreover, although it is not commonly done, it might be substantively interesting to examine the impact of the variables in other situations than the one represented by their means. Therefore, to provide a more nuanced analysis of the variables’ effects on deterrence success and on war, we calculate predicted probabilities holding (1) all other variables constant at their minimum values (this is the “Min” column in Table 2), (2) all other non-dichotomous variables at their mean values and the dichotomous variables at 0 (the “Mean₀” column), (3) all other non-dichotomous variables at their mean values and the dichotomous variables at their median values (the “Mean” column), (4) all other non-dichotomous variables at their mean values and the dichotomous variables at 1 (the “Mean₁” column), and (5) all other variables at their maximum values (the “Max” column).

In general, the “minimum” case is one where the defender does not possess nuclear weapons, where the balance of forces greatly favors the potential attacker, where no military alliance exists between the defender and the protege, where military arms transfers and foreign trade between the defender and the protege are low, where the defender and the protege are not contiguous, and where a tit-for-tat military bargaining strategy is not used by the defender. In other words, the

| | | Min | Mean ₀ | Mean | Mean ₁ | Max |
|-------------------|---|-----|-------------------|------|-------------------|-----|
| Nuclear | 0 | 0 | .4 | .87 | 1 | 1 |
| | 1 | .99 | .95 | .99 | 1 | 1 |
| Military Alliance | 0 | 0 | .4 | .87 | .99 | 1 |
| | 1 | 0 | 1 | 1 | 1 | 1 |
| Tit-for-Tat | 0 | 0 | .4 | .4 | 1 | 1 |
| | 1 | 0 | .87 | .87 | 1 | 1 |
| Def-Pr Contiguity | 0 | 0 | .4 | .87 | 1 | 1 |
| | 1 | .61 | .4 | .87 | 1 | 1 |

Table 3: Effect of Nuclear, Military Alliance, TFT, and Defender-Protege Contiguity on the Probability of Deterrence Success. *Nuclear, Military Alliance, TFT, and ContigDP* are each dummy variables. The table shows the probability of deterrence success (or, equivalently, of the status quo outcome) when each of these variables takes on the values of zero or one, and when the other explanatory variables are held constant at their minimum, mean/median, and maximum values (see Table 2).

“minimum” case is one where we would not expect the attacker to be deterred. The “maximum” case is exactly the opposite: the defender possesses nuclear weapons; the balance of forces greatly favor the defender-protege; a military alliance exists; there are high levels of foreign trade and arms transfers; the defender and the protege are contiguous, and a tit-for-tat bargaining strategy is used. For reference, the actual values of the five cases are displayed in Table 2. Of course, no crisis in the data perfectly matches the combination of values expressed by any of the five cases. They are simply references or ideal types for the analysis.

We address the effect of each variable in turn, referring to Figures 4 and 5 for the effects of the continuous variables on the probability of deterrence success and of war, respectively. Tables 3 and 4 display the effects of the binary variables on the deterrence success and war probabilities, respectively. (Note that in Figures 4 and 5, to avoid cluttering the graphs, we only present the “Min,” “Mean,” and “Max” cases. In Tables 3 and 4 we present all five cases.) Note that deterrence success is equivalent to a status quo outcome. Hence, the probability of the capitulation outcome can be determined at any time by adding the probability of deterrence success and of war, and then subtracting that from one.

Nuclear Weapons

We see in Table 1 that, in the context of our extended immediate deterrence model, the defender’s possession of nuclear weapons is not a statistically significant component of the attacker’s

| | | Min | Mean ₀ | Mean | Mean ₁ | Max |
|-------------------|---|-----|-------------------|------|-------------------|-----|
| Nuclear | 0 | .83 | .6 | .13 | 0 | 0 |
| | 1 | .01 | .05 | 0 | 0 | 0 |
| Military Alliance | 0 | .83 | .6 | .13 | 0 | 0 |
| | 1 | 0 | 0 | 0 | 0 | 0 |
| Tit-for-Tat | 0 | .83 | .6 | .6 | 0 | 0 |
| | 1 | .83 | .13 | .13 | 0 | 0 |
| Def-Pr Contiguity | 0 | .83 | .6 | .13 | 0 | 0 |
| | 1 | .39 | .6 | .13 | 0 | 0 |

Table 4: Effect of Nuclear, Military Alliance, TFT, and Defender-Protege Contiguity on the Probability of War. *Nuclear, Military Alliance, TFT, and ContigDP* are each dummy variables. The table shows the probability of war when each of these variables takes on the values of zero or one, and when the other explanatory variables are held constant at their minimum, mean/median, and maximum values (see Table 2).

utility for war, although it is in the defender’s utility. Through the probabilities in the expected utility calculations, p_d and $p_{\bar{d}}$, the effects of the defender’s possession of nuclear weapons enter back into the attacker’s decision concerning whether to attack. Tables 3 and 4 display the estimated probabilities when the defender does (1) and does not (0) possess nuclear weapons. In the minimum case, when the defender does not possess nuclear weapons, there is virtually zero probability the attacker will be deterred, coupled with a high probability of war (.83). Incredibly, the defender’s possession of nuclear weapons increases the probability of deterrence success from (virtually) zero to almost one (.99) and decreases the probability of war from .83 to .01. In the “Mean₀” case, possession of nuclear weapons increases the probability of deterrence success from .4 to .95 and decreases the probability of war from .6 to .05. In the “Mean” case, p_{sq} increases from .87 to .99 and p_{war} decreases from .13 to (virtually) zero. In the “Mean₁” and “Max” cases, nuclear weapons make no difference in deterrence success — other deterrent factors are sufficient to prevent an attack and war.

Immediate Balance of Forces

As Figure 4(a) shows, the monotonicity and direction of the effect of the immediate balance of forces is the same as in Huth (1988): as the immediate balance of forces increases in favor of the defender-protege, the probability that the potential attacker is deterred increases. However, the rate of increase differs substantially depending on the values at which the other variables are held. In the “Max” case, other deterrent factors are sufficient to ensure that the attacker does not

attack, and IBF has no effect.

In the “Min” case, the probability of deterrence success is zero when IBF ranges from 0 to about .45. After that, however, the probability starts increasing rapidly and reaches almost .7 by the time IBF has increased to about .8. After that, the probability of deterrence success continues to increase, but at a much slower rate. Interestingly, the dramatic increase in the probability of deterrence success occurs well before the defender-protege has achieved parity in immediate balance of forces with the attacker (i.e, well before $IBF=1$).

In the “Mean” case, other deterrents are more abundant than in the “Min” case, and the probability of deterrence success is higher. The steepest increase in the probability of deterrence success in the “Mean” case occurs at very low levels of IBF .

Figure 5(a) displays the effect of the immediate balance of forces on the probability of war between the attacker and the defender. In the “Max” case, the attacker is deterred and so the probability of war is zero. In the “Mean” case, as the immediate balance of forces comes to increasingly favor the defender-protege, the probability of war declines, as the attacker is more likely to be deterred (however, the defender is more likely to defend, leading to war, in those cases in which the attacker chooses to attack).

Of most interest is the “Min” case, which displays a nonmonotonic relationship between the immediate balance of forces and the probability of war. p_{war} initially increases, and then starts decreasing, as IBF increases. This relationship is quite intuitive when one considers the strategic behavior represented by the model. When the immediate balance of forces greatly favors the attacker (i.e., when IBF is very low), the probability of deterrence success is zero (Figure 4(a)). In fact, this probability remains zero until IBF reaches about .45, at which point it starts increasing. As IBF increases from 0 to .45, the defender becomes more likely to defend the protege, as the immediate balance of forces is increasingly in its favor. Hence, the probability of war rises. Once IBF increases beyond .45, the attacker is more likely to be deterred, and hence the probability of war starts decreasing (although, as above, the defender is more likely to defend, leading to war, in those cases in which the attacker chooses to attack). Note that in the “Min” case, in which there are fewer other deterrents, the probability of war is always higher than in the “Mean” case (for any given value of IBF).

Short-Term Balance of Forces

As Figures 4(b) and 5(b) demonstrate, the strategic dynamic for the short-term balance of forces is similar to that of the immediate balance of forces. Consider the “Min” case. The probability of deterrence success remains zero until SBF reaches about 1.25, at which point it starts increasing rapidly. Because p_{sq} remains constant until $SBF=1.25$, we observe a non-monotonic probability

of war, for the same reason that we did for *IBF* above. For the “Mean” and “Max” cases, the probability of deterrence success increases as *SBF* increases, and hence the probability of war decreases (although, as above, the defender is more likely to defend, leading to war, in those cases in which the attacker chooses to attack).

Military Alliance

The effects of a military alliance between the defender and the protege can be seen in Tables 3 and 4. In the “Min” case, the probability of successful deterrence is zero, regardless of whether the defender and protege have a formal alliance (recall that in the minimum case, the balance of forces overwhelmingly favors the attacker). However, the presence of an alliance decreases the probability of war from .83 to almost zero. The implication is that the presence of an alliance makes it almost certain that the defender will capitulate, when the balance of forces overwhelmingly favors the attacker. The “selection effect” argument given earlier provides a possible explanation for this non-intuitive result.

In the “Mean₀” case, the presence of a military alliance increases the probability of deterrence success from .4 to one (recall from Table 1 that a defender-protege military alliance decreases the attacker’s utility for war), and decreases the probability of war from .6 to zero. Similarly, in the “Mean” case, a military alliance increases the probability of deterrence success from .87 to one and decreases the probability of war from .13 to zero. In the “Mean₁” and “Max” cases, the presence of other deterrents ensure that the probability of deterrence success is about one and hence the probability of war about zero, regardless of whether or not a military alliance exists between the defender and the protege.

Military Arms Transfers

The effects of military arms transfers are displayed in Figures 4(d) and 5(d). In the “Max” case, military arms transfers have no effect whatsoever: the probability of deterrence success is one and the probability of war is zero, regardless of the value of *MILARM* (recall that in the “Max” case, the balance of forces overwhelmingly favors the defender-protege, so that this result makes sense).

In the “Mean” case, the probability of deterrence success increases as *MILARM* increases. This is because the attacker knows that the defender is more likely to fight, and hence chooses not to attack. Accordingly, the probability of war decreases as *MILARM* increases (although the defender is more likely to defend, resulting in war, in those cases in which the attacker chooses to attack).

In the “Min” case, the probability of deterrence success remains constant at zero as *MILARM* increases from 0 to about 4.5, after which it starts increasing rapidly. As with *IBF* and *SBF*, this lead to a nonmonotonic probability of war. As *MILARM* increases from 0 to 4.5, the probability of deterrence success remains constant at 0, and the defender becomes increasingly likely to defend

the protege. Hence, the probability of war increases. For higher values of *MILARM*, the probability of deterrence success increases rapidly, and hence the probability of war decreases (although, as above, the defender is more likely to defend, resulting in war, in those cases in which the attacker chooses to attack).

Foreign Trade

The foreign trade variable measures the protege's share of the defender's total merchandise exports and imports and, thus, how economically valuable the protege is to the defender. *FORTRADE* and *MILARM* are both ex ante indicators of the defender's level of interest in defending the protege (Fearon 1994), and hence we would expect them to have the same general effect on the probability of deterrence success and of war. However, this turns out not to be the case. Figures 4(e) and 5(e) display the effects of the defender-protege foreign trade on the probabilities of deterrence success and of war, respectively. In the "Max" case, as usual, the probability of deterrence success is one, and hence the probability of war zero, regardless of the value of *FORTRADE*.

In the "Min" case (in which the balance of forces overwhelmingly favors the attacker), at extremely low levels of *FORTRADE* (from 0 to about 0.5), the attacker is never deterred. However, the defender becomes more likely to defend the protege, and hence the probability of war increases over this range. As *FORTRADE* increases from about 0.5 to about 1, the defender becomes increasingly likely to defend the protege (as always), and hence the attacker becomes less likely to attack. Thus, the probability of deterrence success increases and the probability of war decreases over this range (although the defender is more likely to defend, resulting in war, in those cases in which the attacker attacks). However, at higher levels of *FORTRADE*, despite the defender's greater willingness to defend, the attacker is less likely to be deterred (i.e., the probability of deterrence success decreases), and the probability of war increases. This suggests that unlike *MILARM*, *FORTRADE* is an indicator of not only of the defender's interest in the protege, but the attacker's as well. Indeed, as seen in Table 1, increasing *FORTRADE* not only increases the defender's utility for war, but decreases the attacker's utility for the status quo (relative to the other outcomes) as well. A protege that accounts for a large percentage of its defender's total merchandise exports and imports is valuable not only to the defender, but to a potential attacker as well. Hence, as *FORTRADE* increases, both defender and attacker become more willing to fight over the protege, and the probability of war increases.

In the "Mean" case, the probability of deterrence success decreases as *FORTRADE* increases. Because the protege becomes an increasingly valuable target, the attacker is less likely to be deterred, despite the fact that the defender is more likely to defend. Thus, the probability of war increases.

Tit-for-Tat Military Preparations

Tables 3 and 4 display the effects of the defender's using a strategy of tit-for-tat military preparations in the crisis. In the "Min" case, it has no effect on the probabilities of deterrence success or war, which remain constant at zero and .83, respectively. In the "Mean₀" and "Mean" cases, the defender's use of tit-for-tat military preparations increases the probability of deterrence success from .4 to .87 and decreases the probability of war from .6 to .13. In the "Mean₁" and "Max" cases, the use of tit-for-tat has almost no effect, with deterrence success virtually guaranteed due to other factors.

Defender-Protege Contiguity

The final variable analyzed is defender-protege contiguity. Tables 3 and 4 display the effects of defender-protege contiguity. In the "Min" case, defender-protege contiguity increases the probability of deterrence success from 0 to .61, and decreases the probability of war from .83 to .39. In the "Mean₀," "Mean," "Mean₁," and "Max" cases, defender-protege contiguity has no discernible effect on the probabilities of deterrence success and of war.

3.4 Model Fit

On a final note, although the relevance of model fit is a much debated subject, we believe it provides information that, when not stretched beyond its intended use, can be helpful. Signorino (1999) also suggests that poor model fit may be a sign of a misspecified model, which would cast doubt on the parameter estimates.

In discrete choice models such as logit and probit, a commonly used measure of goodness of fit is the percentage of the outcomes (i.e., realizations of the dependent variable) correctly predicted. Table 1 provides the percentage of the the attacker's actions (i.e., deterrence success versus failure) correctly predicted (%CP Deter) and the percentage of the model's outcomes correctly predicted (%CP Outcomes). The strategic deterrence model correctly predicts (actually, postdicts) over 91% of the outcomes and almost 97% of the attacker's actions. That level of model fit is remarkable for the international relations literature (Huth 1988 correctly predicts 84% of the attacker's actions), where it is not uncommon for (especially discrete choice) models to barely predict above the null. The fact that our statistical model is also a theoretical deterrence model, the fact that it is populated by statistically significant and theoretically justified regressors, the fact that the estimate of the attacker's utility for the defender's capitulation is consistent with our theory of what it should be, the fact that most of the regressors have effects that seem reasonable and can be explained in the context of the model — all of this in combination with the extremely high predictive power provides substantial evidence for the model as an explanation of extended immediate deterrence. Having

said that, the percentage of the outcomes correctly predicted (91%) is not as high as the percentage of the attacker's actions correctly predicted (almost 97%). There is still room for improvement.

4 Concluding Remarks

We have presented the first unified theory and test of extended immediate deterrence. Contrary to Huth (1988), our empirical analysis suggests that nuclear weapons, military alliances, military arms transfers, and foreign trade all affect deterrence success. Moreover, in terms of model fit, our model correctly predicts almost 97% of the potential attacker's actions and over 91% of the crisis outcomes. We also find evidence that the likelihood of deterrence success and of war are not consistent with the typical (monotonic) structural assumptions of previous studies using logit and probit.

Although our model fares quite well, we believe a number of avenues of research would prove fruitful. First, more and better data needs to be collected. As we mentioned previously, we are fortunate as it is to have the Huth (1988) and Huth and Russett (1988) data, which allow us to code the outcomes of our model. However, there are only fifty-eight observations, which makes estimation difficult for larger models (both in terms of number of regressors, as well as number of information sets in the model). Additional data would not only assist in estimation, but would allow us to assess model fit by testing out-of-sample predictions. Huth (1988) suggests that these fifty-eight observations appear to comprise the entire universe of extended immediate deterrence crises in the international system over the time period of 1885 to 1984; if that is the case, then additional observations can only come from other time periods.

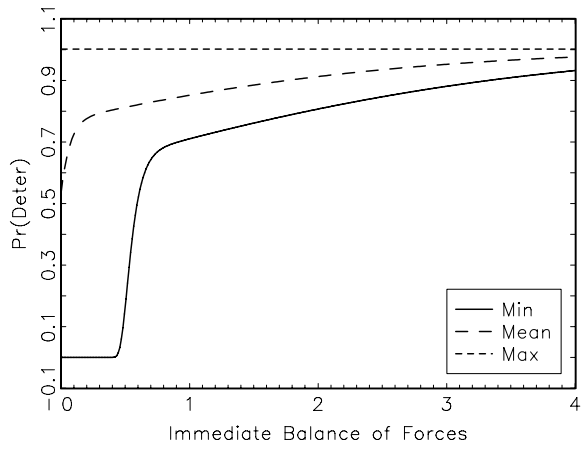
Second, we raised the issue of selection bias in the text, but did not attempt to extend the model any further than that presented here. It is somewhat surprising that our simple deterrence model goes as far as it does. Nevertheless, there are a few puzzling estimates that may be due to how states selected themselves into the current sample. The next obvious step would be to incorporate the prior round or two of interaction into the current model (see Fearon 1994 for a theoretical model that does this). The fact that that would add more outcomes is somewhat problematic in the current context. First, we would need the additional data to code those prior outcomes in our dependent variable (in principle, this shouldn't be a problem if the historical record provides a fairly clear picture as to how those interactions ended). Second, we would need to specify utilities and possibly additional explanatory variables for those outcomes, placing an even larger burden on the fifty-eight observations available. Fortunately, analyzing a model that incorporates prior rounds of interaction (such as Fearon's) would expand the potential population of cases beyond simply those of immediate deterrence. That is, additional observations could be obtained from the

same temporal domain as the Huth (1988) and Huth and Russett (1988) data. All this suggests that theoretically-informed statistical analysis of the factors that influence crisis behavior remains a fruitful and exciting avenue for future research.

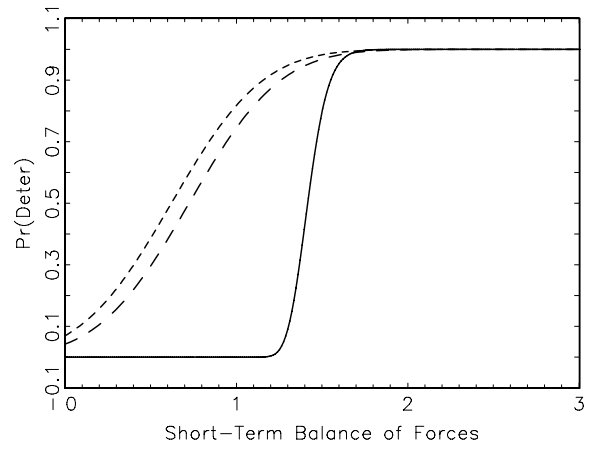
References

- [1] Achen, Christopher H., and Duncan Snidal. 1989. "Rational Deterrence Theory and Comparative Case Studies." *World Politics* 41(2):143–69.
- [2] Fearon, James D. 1994. "Signaling Versus the Balance of Power and Interests." *Journal of Conflict Resolution* 38(2):236–69.
- [3] Huth, Paul K. 1988. *Extended Deterrence and the Prevention of War*. New Haven: Yale University Press.
- [4] Huth, Paul K. 1990. "The Extended Deterrent Value of Nuclear Weapons." *Journal of Conflict Resolution* 34(2):270–90.
- [5] Huth, Paul K., and Bruce Russett. 1984. "What Makes Deterrence Work? Cases from 1900 to 1980." *World Politics* 36:496–526.
- [6] Huth, Paul K., and Bruce Russett. 1988. "Deterrence Failure and Crisis Escalation." *International Studies Quarterly* 32:29–45.
- [7] Huth, Paul K., and Bruce Russett. 1993. "General Deterrence Between Enduring Rivals: Testing Three Competing Models." *American Political Science Review*. 87(1):61–73.
- [8] Huth, Paul, Christopher Gelpi, and D. Scott Bennett. 1993. "The Escalation of Great Power Militarized Disputes: Testing Rational Deterrence Theory and Structural Realism." *American Political Science Review* 87(3):609–23.
- [9] Kilgour, D. Marc, and Frank C. Zagare. 1991. "Credibility, Uncertainty, and Deterrence." *American Journal of Political Science* 35(2).
- [10] Kugler, Jacek, and Frank C. Zagare. 1987. *Exploring the Stability of Deterrence*. Boulder: University of Denver Press.
- [11] Morgan. 1977. *Deterrence: A Conceptual Analysis*. Beverly Hills, CA: Sage.
- [12] Morrow, James D. 1994. "Alliances, Credibility, and Peacetime Costs." *Journal of Conflict Resolution* 38:270–97.
- [13] Morrow, James D. 1999. "The Strategic Setting of Choices: Signaling, Commitment, and Negotiation in International Politics." in Lake, David A., and Robert Powell. (eds.). *Strategic Choice in International Relations*. Princeton: Princeton University Press.
- [14] Powell, Robert. 1990. *Nuclear Deterrence Theory*. Cambridge: Cambridge University Press.
- [15] Signorino, Curtis S. 1999. "Strategic Interaction and the Statistical Analysis of International Conflict." *American Political Science Review* June.
- [16] Signorino, Curtis S. 2000. "Theoretical Sources of Uncertainty in Statistical Strategic Models." Working Paper. University of Rochester.
- [17] Signorino, Curtis S., and Kuzey Yilmaz. 2000. "Strategic Misspecification in Discrete Choice Models." Working Paper. University of Rochester.

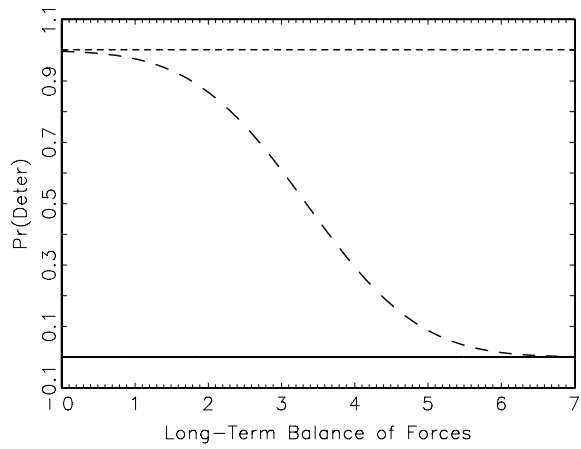
- [18] Stern, Paul C., Robert Axelrod, Robert Jervis, and Roy Radner (eds.). 1989. *Perspectives on Deterrence*. Oxford: Oxford University Press.
- [19] Werner, Suzanne. 2000. "Deterring Intervention: The Stakes of War and Third-Party Involvement." *American Journal of Political Science* 44(4):720–32.
- [20] Zagare, Frank C., and D. Marc Kilgour. 1993. "Asymmetric Deterrence." *International Studies Quarterly* 37(1).
- [21] Zagare, Frank C., and D. Marc Kilgour. 2000. *Perfect Deterrence*. Cambridge: Cambridge University Press.



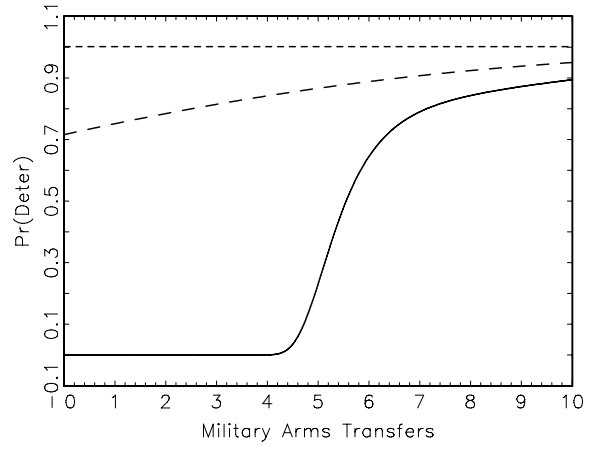
(a)



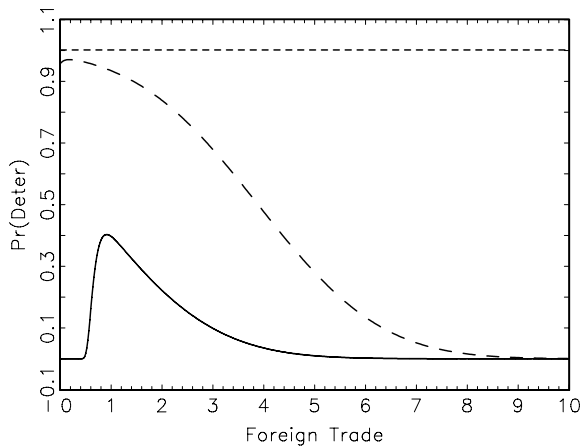
(b)



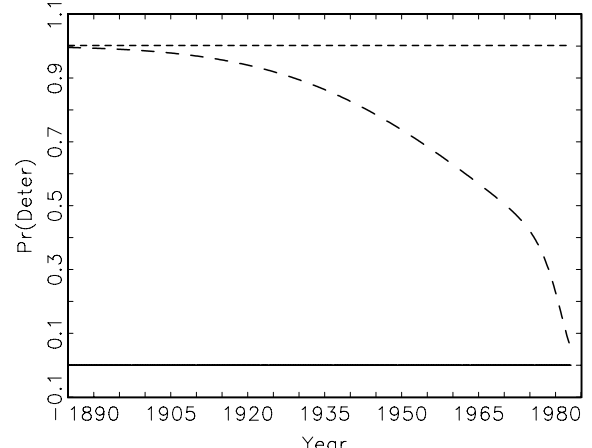
(c)



(d)

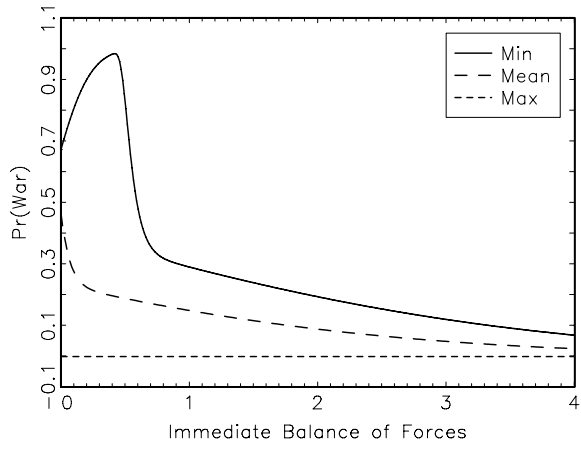


(e)

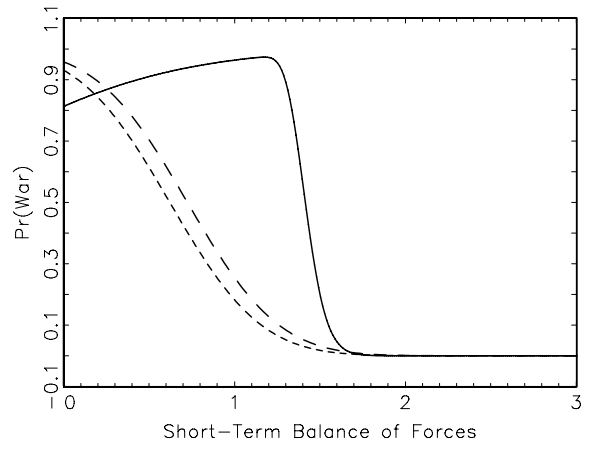


(f)

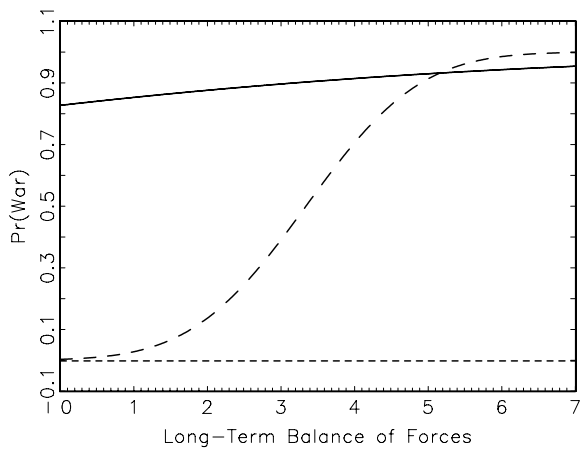
Figure 4: Effects of Explanatory Variables on the Probability of Deterrence Success. *Each plot displays the probability of deterrence success (or, equivalently, of the status quo outcome) as a function of one of the explanatory variables, holding all other variables at their minimum (solid line), mean/median (long dash), and maximum (short dash) values. The minimum, mean/median, and maximum values are given in Table 2.*



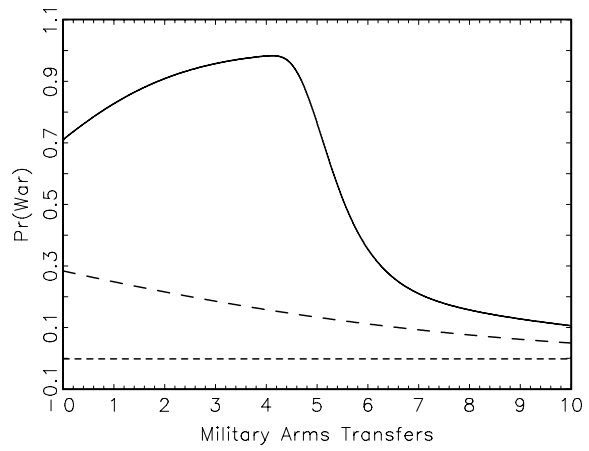
(a)



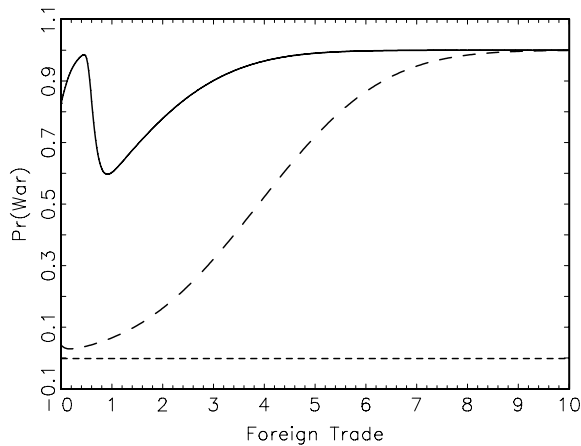
(b)



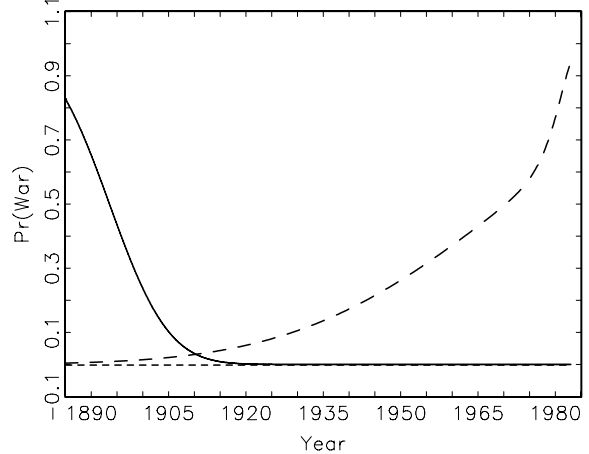
(c)



(d)



(e)



(f)

Figure 5: Effect of Explanatory Variables on the Probability of War. Each plot displays the probability of war between the attacker and the defender as a function of one of the explanatory variables, holding all other variables at their minimum (solid line), mean/median (long dash), and maximum (short dash) values. The minimum, mean/median, and maximum values are given in Table 2.