Supplementary Material

THE RATIFICATION PREMIUM
Hawks, Doves, and Arms Control

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World Politics
doi: 10.1017/S0043887118000102

Qualitative data are available at:

Kreps, Sarah E., Elizabeth N. Saunders, and Kenneth A. Schultz. 2018. "Qualitative Data for: The Ratification Premium: Hawks, Doves, and Arms Control." Qualitative Data Repository. doi: 10.5064/F6KMEDVB.

This appendix contains details on the formal model presented in the paper. The first section develops some preliminary results needed to solve the mode. Section 2 presents propositions with the equilibria to the game without side payments. Section 3 presents the equilibrium to the game with side payments when the president is a dove.

1. Preliminaries

The utility of actor $i \in \{P, E, L\}$ in D from military effort m_D and m_F is given by

$$U_i(m_D; m_F) = (1 - m_D) + \gamma_i \frac{m_D}{m_D + m_F}. \tag{A.1}$$

Given m_F and γ_i, actor i's utility is maximized at $m_i*(m_F) = \sqrt{\gamma_i m_F} - m_F$. The second derivative of (A.1) with respect to m_D is everywhere negative, so the utility function is single-peaked. Note that, for an actor to want a positive level of military spending, it must be the case that $\gamma_i > m_F$. We will assume this condition holds throughout. In addition, we assume that m_i* is increasing in *F*'s effort, m_F, for all *i*. This assumption rules out situations in which actors prefer to spend more in response to cuts by *F* than they do in the status quo. Technically, this requires $\gamma_i > 4m_F$.

Given status quo military allocations, m_i^{SQ}, an actor *i* in *D* would prefer lower military spending in the status quo if γ_i is low enough. Let $\bar{k}_i^{SQ}$ denote the maximum level of cuts that actor *i* would be willing to enact given the status quo allocations. This means that $\bar{k}_i^{SQ}$ solves $U_i(m_D^{SQ}; m_F^{SQ}) = U_i(m_D^{SQ} - \bar{k}_i^{SQ}; m_F^{SQ})$, or

$$\bar{k}_i^{SQ} = M^{SQ} - \gamma_i \frac{m_F^{SQ}}{M^{SQ}},$$

where $M^{SQ} = m_D^{SQ} + m_F^{SQ}$. It is easy to confirm that $\overline{k}_i^{SQ}$ is decreasing in γ_i and that $\overline{k}_i^{SQ} > 0$ for γ_i sufficiently low.[1] We assume that $\overline{k}_i^{SQ} < 0$ for $i \in \{E, L\}$, but leave open the possibility that $\overline{k}_P^{SQ} > 0$, so that the president would want to cut military effort unilaterally in the status quo.

In the event of arms control treaty reducing the foreign state's military effort to $m_F^T < m_F^{SQ}$, each actor *i* in *D* has a most preferred level of cuts in the good state of the world, given by

$$\begin{aligned} k_i^* &= m_D^{SQ} - m_i^*(m_F^T) \\ &= m_D^{SQ} - \left(\sqrt{\gamma_i m_F^T} - m_F^T\right). \\ &= m_D^{SQ} + m_F^T - \sqrt{\gamma_i m_F^T} \end{aligned}$$

Note that the optimal level of cuts is monotonically decreasing in hawkishness, and there is no guarantee that it is greater than zero. Each actor in *D* also has a maximum levels of cuts that it[2] would be willing to accept over the status quo in the good state of the world, denoted by $\overline{k}_i$. Recalling that *E* and *L* gain a partisan benefit, $\pi \geq 0$, for rejecting a treaty, $\overline{k}_i$ solves

$$U_i(m_D^{SQ}; m_F^{SQ}) + \delta_i \pi = U_i(m_D^{SQ} - \overline{k}_i; m_F^T),$$

where $\delta_i = 1$ if $i \in \{E, L\}$. A closed form expression for $\overline{k}_i$ is messy, but we can establish several results:

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[1] Moreover, there exist values of γ_i that satisfy this condition and the condition that $\gamma_i > 4m_F$ as long as $m_D^{SQ} > m_F^{SQ}$.

[2] Hereinafter, we will use the pronoun "he" when referring to the president and "she" when referring to the endorser and pivotal legislator.

1. $\bar{k}_i$ is monotonically decreasing in γ_i, so more hawkish actors are willing to accept fewer cuts.
2. $\bar{k}_i$ is monotonically decreasing in π, so that more biased actors are willing to accept fewer cuts.

It will also be useful to define $\bar{k}_L(q)$ as the largest level of cuts *L* will be willing to ratify if she believes the state of the world is good with probability *q*. It is easy to show that this function is increasing in *q* and that $\bar{k}_L$, as defined above, is equivalent to $\bar{k}_L(1)$. The assumption that *L* does not want cuts in the status means that $\bar{k}_L(0) \leq 0$.

Finally, a crucial aspect of the solution is that there exists a level of hawkishness, $\gamma *$, such that for $\gamma_P < \gamma *$, $\bar{k}_P^{SQ} > \min\left(k_P*, \bar{k}_L\right)$, so that the bad world president would like to enact the level of cuts that either the good world president considers ideal and/or *L* is willing to ratify. Under these conditions, there is a danger that the bad world president will mimic a proposal by a good world president, leading to the credibility problem at the heart of this interaction. As discussed in the text, we consider the case where the this critical threshold is met when $k_P* > \bar{k}_L$.

2. Solution without side payments

The first proposition covers the cases in which *P* is not a dove.

PROPOSITION 1. The following strategies and beliefs comprise a perfect Bayesian equilibrium to the game under the specified conditions for the president's preference type:

(1.1) If the state of the world is bad, *P* signs no deal, or $k_D = 0$. If the state of the world is good, *P* proposes a deal with cuts $k_D = k*$, where

$k^* = 0$ if P is a Hawk ($\underline{k}_D > \overline{k}_P > k_P^* > \overline{k}_P^{SQ}$),

$k^* = \underline{k}_D$ if P is a Moderate Hawk ($\overline{k}_P > \underline{k}_D > k_p^* > \overline{k}_P^{SQ}$),

$k^* = k_P^*$ if P is a Moderate ($\overline{k}_L > k_P^* > \underline{k}_D, \overline{k}_P^{SQ}$), and

$k^* = \overline{k}_L$ if P is a Moderate Dove ($k_P^* > \overline{k}_L > \overline{k}_P^{SQ}$).

(1.2) E endorses the deal if and only if the state of the world is good and $k_D \leq \overline{k}_E$.

(1.3) L ratifies the deal if $\overline{k}_L \geq k_D \geq \overline{k}_P^{SQ}$ or if $k_D \leq \overline{k}_L$ and E endorsed the deal, and not otherwise. Since $k_D = k^*$ always meets the first condition, the deal will always be ratified on the equilibrium path.

(1.4) On the equilibrium path,

$$q' = \begin{cases} 0 & \text{if } k_D = 0 \\ 1 & \text{if } k_D = k^* \end{cases}$$

In the event of an off-the-equilibrium path (OEP) proposal $\tilde{k}_D \notin \{0, k^*\}$,

$$q' = \begin{cases} 0 & \text{if } \tilde{k}_D < \overline{k}_P^{SQ} \text{ and E does not endorse} \\ 1 & \text{if } \tilde{k}_D \geq \overline{k}_P^{SQ} \text{ or E endorses} \end{cases}$$

PROOF. The endorser's strategy in (1.2) follows from the fact that she prefers a treaty to the status quo only under the specified conditions and not, otherwise. The endorser has no incentive to withhold endorsement from a treaty she prefers to the status quo nor to endorse a treaty that she does not. L's strategy in (1.3) follows from the fact that she will ratify if $k_D \leq \overline{k}_L(q')$ and not otherwise. If E endorsed or $k_D \geq \overline{k}_P^{SQ}$, then from (1.4) we know that $q' | k_D = 1$, so it is rational to ratify as long as $k_D \leq \overline{k}_L$. If E did not endorse or $k_D < \overline{k}_P^{SQ} < k^*$, then $q' | k_D = 0$, and L prefers the status quo to any deal.

The key factor driving behavior in these cases is that $k^* > \bar{k}_P^{SQ}$, so that the equilibrium proposal of the good world president has deeper cuts than the bad world president is willing to tolerate. As a result, the latter never has an incentive to mimic any (non-zero) proposal made by the former, and *L* can infer from the proposal that the state of the world is good. In all of these cases, *E*'s endorsement, whether or not it is given, is superfluous to *L*'s decision (on the equilibrium path). Given this, the good world president's strategy follows directly from the preference orderings of the different types: a hawk prefers no deal to the minimum required by the foreign state; a moderate hawk is willing to make the minimum cuts needed to get an agreement ($\underline{k}_D$); a moderate proposes his ideal level of cuts; and a moderate dove proposes the maximum level of cuts the legislature will approve.

The beliefs in (1.4) follow from the equilibrium strategies or are sensible assumptions. The OEP beliefs mean that *L* assumes the state of the world is bad if *P* makes an unexpectedly low proposal that would benefit the bad world president and that the state of the world is good if the proposed cuts are deeper than the bad world president would tolerate. Given these beliefs, the bad world president would never have an incentive to deviate to some alternative deal, since any deal he would prefer to the status quo ($\tilde{k}_D < \bar{k}_P^{SQ}$) will be rejected. The costs of having a deal rejected rule out such a deviation. □

The next three propositions deal with the case in which *P* is a dove ($k_P^*, \bar{k}_P^{SQ} > \bar{k}_L$). Unlike in the cases covered by Proposition 1, in this case the bad world president is willing to mimic the most dovish deal that *L* will ratify. Thus, on seeing such a proposal, *L* cannot be sure that the state of the world is good, making the endorser's message important. We first deal with the case in which *E* is more dovish that *L*, or $\bar{k}_E \geq \bar{k}_L$:

PROPOSITION 2. The following strategies and beliefs comprise a perfect Bayesian equilibrium to the game when *P* is a dove ($k_P*, \overline{k}_P^{SQ} > \overline{k}_L$) and $\overline{k}_E \geq \overline{k}_L$:

(2.1) If the state of the world is bad, *P* signs no deal, or $k_D = 0$. If the state of the world is good, *P* proposes cuts $k_D = \overline{k}_L$.

(2.2) *E* endorses the deal if and only if the state of the world is good and $k_D \leq \overline{k}_E$.

(2.3) *L* ratifies the deal if $k_D \leq \overline{k}_L$ and *E* endorsed the deal, but not otherwise. On the equilibrium path, *L* ratifies the treaty.

(2.4) Beliefs are the same as in (1.4) above.

PROOF. Most of the proof follows the same logic as in Proposition 1. Because $\overline{k}_E \geq \overline{k}_L$, *E* is willing to endorse the most dovish deal that *L* will ratify if and only if the state of the world is good. Therefore, *E*'s ability to withhold her endorsement deters the bad world *P* from mimicking that deal, and *L* ratifies for certain upon seeing the endorsement. □

The equilibria that exist when *P* is a dove and $\overline{k}_E < \overline{k}_L$ are more complicated. We identify two forms of perfect Bayesian equilibrium. The first is a separating equilibrium in which the good world *P* proposes cuts of $k_D = \overline{k}_E$ and the bad world *P* does not sign a treaty.

PROPOSITION 3. The following strategies and beliefs comprise a perfect Bayesian equilibrium to the game when *P* is a dove ($k_P*, \overline{k}_P^{SQ} > \overline{k}_L$) and $\overline{k}_E < \overline{k}_L$:

(3.1) If the state of the world is bad, *P* signs no deal, or $k_D = 0$. If the state of the world is good, *P* proposes a deal with cuts $k_D = \overline{k}_E$.

(3.2) *E* endorses the deal if and only if the state of the world is good and $k_D \leq \overline{k}_E$.

(3.3) L ratifies the deal if $k_D \leq \bar{k}_L$ and E endorsed the deal, but not otherwise.

(3.4) Beliefs are the same as in (1.4) above.

PROOF. Most of the proof follows the same logic as in Proposition 1. In this case, the good world president proposes the deepest cuts that E is willing to endorse, and E endorsers the deal only if the state of the world is good. If the deal is endorsed, L knows that the state of the world is good and, since the condition in (3.3) is always met when $\bar{k}_E < \bar{k}_L$, L ratifies the deal. Off the equilibrium path, the assumption in (3.4) implies that any deviation to a higher level of cuts $\tilde{k}_D \in (\bar{k}_E, \bar{k}_L]$ leads L to believe that the state of the world is bad—since, in this range, $\tilde{k}_D < \bar{k}_P^{SQ}$ and E will not endorse. Such a deal will fail, making such a deviation unprofitable. □

There also exists a continuum of semi-separating equilibria. To assist in the definition of these equilibria, define q^* as the value of q such that $\bar{k}_L(q^*) = \bar{k}_E$. It follows that, for all $\hat{q} \in (q^*, 1]$, $\bar{k}_L(\hat{q}) > \bar{k}_E$.

PROPOSITION 4. The following strategies and beliefs comprise a perfect Bayesian equilibrium to the game when P is a dove ($k_P^*, \bar{k}_P^{SQ} > \bar{k}_L$), $\bar{k}_E < \bar{k}_L$, and expression (A.2), below, holds:

(4.1) For any given $\hat{q} \in (q^*, 1]$, P proposes a deal $k_D = \bar{k}_L(\hat{q}) \in (\bar{k}_E, \bar{k}_L]$ if the state of the world is good. If the state of the world is bad, P proposes $\bar{k}_L(\hat{q})$ with some probability s and signs no treaty with probability $1-s$, with $s = \dfrac{q(1-\hat{q})}{\hat{q}(1-q)}$.

(4.2) E endorses the deal if and only if the state of the world is good and $k_D \leq \bar{k}_E$. Given P's strategy in (1), this means that no treaty is endorsed on the equilibrium path.

(4.3) L ratifies an agreement at $\bar{k}_L(\hat{q})$ with probability r and refuses to ratify with probability $1-r$, with $r = \frac{c}{c + U_P\left(m_D^{SQ} - \bar{k}_L(\hat{q}); m_F^{SQ}\right) - U_P\left(m_D^{SQ}; m_F^{SQ}\right)}$. Off the equilibrium path, L ratifies the deal only if $k_D \leq \bar{k}_L$ and E endorsed the deal.

(4.4) On the equilibrium path, $q' = \frac{q}{q+(1-q)s} = \hat{q}$ if $k_D = \bar{k}_L(\hat{q})$. OEP beliefs are as in (1.4) above.

PROOF. For any feasible $\hat{q}$, the expression for s in (4.1) and the definition of $\hat{q}$ in (4.4) ensure that L is indifferent between ratifying and not ratifying the agreement. In response, L plays a mixed strategy that makes the bad world P indifferent between signing no deal and proposing the same deal as the good world president. The expected utilities from these two choices are:

$$EU_P\left(k_D = 0 \middle| \text{bad}\right) = U_P\left(m_D^{SQ}; m_F^{SQ}\right)$$
$$EU_P\left(k_D = \bar{k}_L(\hat{q}) \middle| \text{bad}\right) = rU_P\left(m_D^{SQ} - \bar{k}_L(\hat{q}); m_F^{SQ}\right) + (1-r)\left[U_P\left(m_D^{SQ}; m_F^{SQ}\right) - c\right]$$

Setting these equal and solving for r yields the expression in (4.3). For any given level of cuts, P's utility is increasing in cuts by F, so the good world P's expected utility from proposing a deal at $k_D = \bar{k}_L(\hat{q})$ is higher than that of the bad world P. As a result, given L's behavior, the good world P strictly prefers making that deal over the status quo. Moreover, given the OEP beliefs, no alternative deal $\tilde{k}_D > \bar{k}_E$ will be endorsed or ratified.

The only potentially profitable deviation for the good world P is to a proposal of $k_D = \bar{k}_E$, which will be endorsed and ratified for certain. Thus, this equilibrium only exists when the good world P's expected payoff on the equilibrium path is greater than he could obtain by deviating. The expected utility for the good world P on the equilibrium path and in this deviation are:

$$EU_P\left(k_D=\overline{k}_L(\hat{q})\middle|\text{good}\right)=rU_P\left(m_D^{SQ}-\overline{k}_L(\hat{q});m_F^T\right)+(1-r)\left[U_P\left(m_D^{SQ};m_F^{SQ}\right)-c\right]$$
$$EU_P\left(k_D=\overline{k}_E\middle|\text{good}\right)=U_P\left(m_D^{SQ}-\overline{k}_E;m_F^T\right).$$

Deviation is not profitable as long as

$$r>\frac{c+U_P\left(m_D^{SQ}-\overline{k}_E;m_F^T\right)-U_P\left(m_D^{SQ};m_F^{SQ}\right)}{c+U_P\left(m_D^{SQ}-\overline{k}_L(\hat{q});m_F^T\right)-U_P\left(m_D^{SQ};m_F^{SQ}\right)}. \tag{A.2}$$

Thus, this equilibrium exists only for values of $\overline{k}_L(\hat{q})$ such that this condition is met. Unfortunately, there is no clean or meaningful statement of the conditions under which (A.2) holds. □

The existence of multiple equilibria necessarily makes predictions indeterminate. We know that the separating equilibrium with the "sure thing" proposal at $k_D=\overline{k}_E$ always exists; some semi-separating equilibria with higher proposals in the range $k_D\in(\overline{k}_E,\overline{k}_L]$ may also exist, but only when it yields the good world *P* greater expected value than the sure thing. In the semi-separating equilibria, the relationship between the equilibrium proposal of the good world president, k_D, and the probability of ratification, *r*, depends on the hawkishness of the president. Let $k_P^{SQ}*$ denote the level of cuts that maximizes the bad world president's utility. For equilibrium offers $k_D<k_P^{SQ}*$, the probability of ratification is decreasing in k_D; for equilibrium offers $k_D>k_P^{SQ}*$, the probability of ratification is increasing in k_D. This means that, while $k_P^{SQ}*<\overline{k}_L$, the probability of ratification in the semi-separating equilibria is first decreasing and then increasing in the level of cuts proposed. If *P* is so dovish that $k_P^{SQ}*>\overline{k}_L$, then the probability of ratification is strictly decreasing in the level of cuts proposed. In either event, any proposal in the continuum $k_D \in (\overline{k}_E, \overline{k}_L]$ is ratified with lower probability than the sure thing proposal at $k_D = \overline{k}_E$, as shown in Figure 1.

3. Solution with side payments

We now consider an equilibrium to the modified version of the game in which *P* can make a side payment to *E* in order to "buy" her endorsement of the treaty. In this case, a strategy for *P* consists of a package (k_D, t) of proposed cuts and transfers. Assume that *P*'s utility is linearly decreasing in *t* and *E*'s utility is linearly increasing in *t*. To focus on the informational effect of the side payments, rather than their direct effect on *L*'s willingness to ratify the deal, we assume that the transfers do not benefit *L*. The main results do not change much if *L* benefits from *t*, but this opens up the possibility of *L* voting to ratify a deal even in the bad state of the world.

The strategy of using side payments only has an informational effect when *P* is dovish ($k_P^*, \overline{k}_P^{SQ} > \overline{k}_L$) and *E* is relatively hawkish *E* ($\overline{k}_E < \overline{k}_L$). Thus, we confine our attention to the solution that holds under those conditions.

PROPOSITION 5. The following strategies and beliefs comprise a perfect Bayesian equilibrium to the game with side payments when *P* is a dove ($k_P^*, \overline{k}_P^{SQ} > \overline{k}_L$) and $\overline{k}_E < \overline{k}_L$:

(5.1) If the state of the world is bad, *P* signs no deal, or $k_D = 0$ and offers no transfer. If the state of the world is good, *P* proposes a deal with cuts $k_D = k^* \in [\overline{k}_E, \overline{k}_L]$ and a transfer $t^* = \underline{t}(k_D)$, with *k** and $\underline{t}(k_D)$ to be defined below.

(5.2) *E* endorses a package (k_D, t) if $t \geq \underline{t}(k_D)$ and the state of the world is good or if $t \geq \underline{t}'(k_D)$ and the state of the world is bad, with $\underline{t}'(k_D) > \underline{t}(k_D)$ to be defined below.

(5.3) L ratifies a package $\left(k_D, t\right)$ if E endorsed the deal and $t < \underline{t}'(k_D)$, but not otherwise.

(5.4) On the equilibrium path,

$$q' = \begin{cases} 0 & \text{if } \left(k_D, t\right) = \left(0,0\right) \\ 1 & \text{if } \left(k_D, t\right) = \left(k^*, t^*\right) \end{cases}$$

In the event of an off-the-equilibrium path (OEP) proposal,

$$q' = \begin{cases} 0 & \text{if E does not endorse or } t \geq \underline{t}'(k_D) \\ 1 & \text{if E endorses and } t < \underline{t}'(k_D) \end{cases}$$

PROOF. Given a proposed level of cuts k_D, and given L's strategy in (5.3), E's expected utility from endorsing and not endorsing in the good state of the world are:

$$\begin{aligned} EU_E(\text{Endorse}) &= U_E(m_D^{SQ} - k_D; m_F^T) + t \\ EU_E(\sim \text{Endorse}) &= U_E(m_D^{SQ}; m_F^{SQ}) + \pi \end{aligned}.$$

Thus, E prefers to endorse in the good state of the world if

$$t \geq U_E(m_D^{SQ}; m_F^{SQ}) - U_E(m_D^{SQ} - k_D; m_F^T) + \pi \equiv \underline{t}(k_D),$$

as stated in (5.2). If the state of the world is bad, then similar calculations show that the transfer needed to obtain E's endorsement must satisfy

$$t \geq U_E(m_D^{SQ}; m_F^{SQ}) - U_E(m_D^{SQ} - k_D; m_F^{SQ}) + \pi \equiv \underline{t}'(k_D).$$

Because E's utility is strictly decreasing in F's military effort, it must be the case that $\underline{t}'(k_D) > \underline{t}(k_D)$. Thus, there exists a set of transfers $\underline{t}'(k_D) > t \geq \underline{t}(k_D)$ such that E will endorse cuts of k_D only in the good state of the world.

If E endorses a package with $t < \underline{t}'(k_D)$, then L can be sure the state of the world is good. In that case, L will vote to ratify as long as $k_D \leq \overline{k}_L$, as assumed. Deviations not endorsed by E

or endorsed in exchange for a transfer $t \geq \underline{t}'(k_D)$ imply the state of the world is bad, leading to *L* to reject the treaty, as stated in (5.3).

The good world *P*'s utility from a proposal at k_D with the minimum transfer needed to ensure ratification, $\underline{t}(k_D)$, is $U_P(m_D^{SQ} - k_D; m_F^T) - \underline{t}(k_D)$. It can be shown that the level of cuts that maximizes the good world *P*'s utility is

$$k^* = m_D^{SQ} + m_F^T - \sqrt{\tilde{\gamma} m_F^T}\,, \tag{A.3}$$

where $\tilde{\gamma} = (\gamma_P + \gamma_E)/2$. Notice that the optimal level of cuts in this scenario decreases with *P*'s hawkishness, so more dovish presidents optimally propose more dovish deals and pay higher transfers to get them ratified.[3] The good world *P* has no incentive to deviate to another package. The bad world *P* cannot mimic the strategy of the good world *P*, since *E* would not endorse in the bad state of the world at the level of transfers proposed. A bad world *P* also has no incentive to buy *E*'s endorsement by offering a package at $(k_D, \underline{t}'(k_D))$ since the large transfer signals to *L* that the state of the world is bad.

Finally, there is no guarantee that the optimal level of cuts in (A.3) is greater than the maximum level of cuts that *E* would endorse "for free," or $\bar{k}_E$. Thus, there may be parameter values for which the optimal package in this equilibrium is $(\bar{k}_E, 0)$ □

Thus, there can exist a separating equilibrium in which the dovish *P* agrees to deeper cuts than *E* would otherwise support to but then wins *E*'s endorsement through a transfer of

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[3] Indeed, the optimal level of cuts in this equilibrium is equivalent to the optimal level for an actor whose hawkishness is the average of *P*'s and *E*'s.

something of value. The level of transfers is increasing in the level of cuts proposed, and both increase as *P* becomes more dovish. Of course, there is no guarantee that the president is better off providing a transfer than he is under one of the alternative equilibria without a transfer. This is particularly true if the endorser is very hawkish and/or has high partisan bias. Thus, if the president can select the equilibrium, he might under some conditions play the one of semi-separating equilibria in Proposition 4, refuse to make a side payment, and take his chances with ratification.