

RAISING THE COST OF REBELLION: THE ROLE OF THIRD-PARTY INTERVENTION IN INTRASTATE CONFLICT

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This paper presents a simple model to characterize explicitly the role that an intervening third party plays in raising the cost of rebellion in an intrastate conflict. Extending the Gershenson-Grossman (2000) framework of conflict in a two-stage game to the case involving outside intervention in a three-stage game as in Chang *et al.* (2007b), we examine the conditions under which an outside party optimally intervenes such that (i) the strength of the rebel group is diminished or (ii) the rebellion is deterred altogether. We also find conditions in which a third party optimally intervenes but at a level *insufficient* to deter rebellion. Such behavior, which improves the incumbent government's potential to succeed in conflict, is overlooked in some conflict studies evaluating the effectiveness of intervention. One policy implication of the model is that an increase in the strength of inter-governmental trade partnerships increases the likelihood that third-party intervention deters rebellion.

Keywords: Intrastate conflict; Third-party intervention; War; Peace

JEL Codes: D74, H56

INTRODUCTION

Outside intervention in intrastate conflict has often been analyzed in the political science and economics literature. Several studies (Collier and Hoeffler, 1998; Balch-Lindsay and Enterline, 2000; Murdoch and Sandler, 2002) discuss the social losses borne out of insurrection, which include human death, injury, and displacement, destruction of physical capital and natural resources within the conflict state, disintegration of property rights, possible creation of rogue lands that come to serve as a terrorist resource, disruption of economic activity, and loss of productive labor to the rebellion. Collier and Hoeffler (2005) estimate the average global economic loss from a single intrastate conflict to be more than \$64 billion.¹

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¹ The majority of conflicts after the Second World War have been intrastate conflicts. Balch-Lindsay and Enterline (2000) report that civil wars constitute 80 of the 104 post-Second World War conflicts. Further, Murdoch and Sandler (2002) observe that the majority of civil wars take place in developing countries. Collier *et al.* (2003) present a systematic survey of studies on civil wars.

Third-party intervention to suppress rebellion has been discussed as an effective means of decreasing the social losses associated with insurrection (Azam *et al.*, 2001). Siqueira (2003) explores the efficacy of third-party interventions that seek to reduce the level of fighting in an intrastate conflict. Among other modes of intervention, he analyzes outside efforts to raise the marginal cost of rebellion. Further, Gershenson (2002) examines the effect of sanctions on intrastate conflict.

However, to fully understand the role and scope of rebel-suppressing third-party intervention in cases of potential or realized intrastate conflict, we must consider both underlying third-party interests and the efficacy with which those interests are served through intervention efforts. According to the paradigm of realism in political science, the supply of rebel-suppressing third-party intervention is predicated upon the direct stakes that an outside party holds with each of the rival parties. While capturing a part of third-party motivation, Regan (1998) finds that the paradigm of realism is too narrow to describe intervention efforts in general. For instance, he discovers that intervention is more likely to occur in the presence of a humanitarian crisis. This result suggests that a representative third party acts partly from moral imperative. Thus, the idealist perspective also plays a part in describing observed third-party behavior.²

Incorporating Regan's findings with respect to third-party motivation, this paper considers the supply and effect of third-party intervention on behalf of an incumbent government by *endogenizing* the third party within a three-stage game-theoretic model of conflict. Further, we use comparative static analysis to discuss what factors may change the supply of third-party intervention. One policy implication of the model is that an increase in the strength of inter-governmental trade partnerships would increase the likelihood that third-party intervention acts to deter rebellion, *ceteris paribus*.

In our analysis, we define the term 'intrastate conflict' as an armed confrontation between interest groups in a state (Gershenson and Grossman, 2000). Our model considers a potential or realized intrastate conflict between two primary parties – an incumbent government and a rebel group. For a given decision period, the situation can end in one of two ways.³ In the first possible outcome, government military spending in defense of the state is sufficient to deter rebellion, and armed confrontation does not ensue. Otherwise, government military spending in defense of the state is insufficient to deter a rebellion, and an armed confrontation between government and the rebel group ensues. To understand the nature of 'biased' third-party intervention on behalf of an incumbent government,⁴ we assume the presence of a third party whose preferred outcome is that the incumbent government retains power over the state. The reasons for this preference may be enhanced access to trade and natural resources, improved national security, ethical fulfillment, and geo-strategic advantage (Collier and Hoeffler, 1998, 2004; Chang *et al.*, 2007a).⁵ The behavior of the third party is examined to find (i) when there is rebel-suppressing third-party intervention, (ii) the marginal effect of said intervention, and (iii) conditions under which a third party has the effect of deterring a rebellion that would otherwise have occurred. A key finding of the paper is that the third party treats an allied government's relative military effectiveness and relative value for political dominance as

² Idealism is defined as 'an approach that emphasizes international law, morality, and international organization, rather than power alone, as key influences on international relations' (Goldstein, 2004: 554).

³ As in Gershenson and Grossman (2000) and Chang *et al.* (2007a), we take each of the rival parties as allocating some amount of military spending in a given 'decision period'. In other words, a decision period is a length of time over which military spending decisions are committed for each party.

⁴ Regan (2002) finds that neutral third-party intervention tends to increase the duration of intrastate conflict. Accordingly, intervention will work to reduce the duration only when it is biased in favor of one party. Rowlands and Carment (2006) remark that recent third-party interventions have seldom been impartial in nature.

⁵ Collier and Hoeffler (1998, 2004) show that economic factors, such as the value of state natural resources, have a strong effect on group decisions regarding civil conflict.

complementary to its own intervention efforts. It does so because intervention efforts are more marginally effective in restraining a rebellion that is relatively ineffective militarily or one that is relatively unmotivated, *ceteris paribus*.⁶ Additionally, we find conditions in which a third party optimally intervenes but at a level *insufficient* to bring an expedited close to the rebellion. It may do so simply to improve the incumbent government's potential to succeed (i.e. to maintain power) in conflict. This result leads us to question the criterion by which some prior studies evaluate the effectiveness of third-party intervention. Notably, Regan (2002) states, 'In decision-theoretic terms, an intervention is trying to maximize the expected utility of each actor for settling now versus continued fighting until an expected victory.' However, Balch-Lindsay and Enterline (2000) consider less straightforward motives in their study of third-party intervention: 'Policymakers often trumpet the potential for third parties to stop the killing associated with civil wars, yet third parties as strategic actors also have incentives to encourage longer civil wars.' We explore such incentives in the present study.

Gershenson and Grossman (2000) develop a rational-choice model to identify the determinants of intrastate conflict. In explaining the onset and persistence of intrastate conflict, their model focuses on the values, intrinsic and economic, that rival parties place on political dominance. We wish to broaden the Gershenson–Grossman framework in this study by considering a model of intrastate conflict that features an endogenous third party. In particular, we analyze the scenario in which a third party considers supporting the incumbent government by means of raising the marginal cost of rebellion. For instance, a third party might impose and enforce targeted arms trade sanctions upon the rebel group. Such sanctions potentially deny the rebel group lowest-cost sources of military goods by forcing it to rely on domestically produced arms and smuggled imports rather than upon freely traded arms. The University of Connecticut's GlobalEd Project defines military intervention as 'external interference in the domestic affairs of another state by military means.' Similarly, Regan and Aydin (2006: 738) adopt a 'broad view of interventions, incorporating various approaches outside parties can use to manage conflicts. As historical events reveal, this can include military, economic, and diplomatic initiatives.' Enforcement of anti-rebel arms sanctions by the United Nations requires the presence of UN troops. Thus, such sanctions constitute third-party military intervention in the sense that the third party allocates defensive military goods to increase the cost of rebel engagement. Targeted arms sanctions have been implemented by the United Nations, for instance, to address civil conflicts in Angola, Sierra Leone, Guinea, and Liberia (Fleshman, 2001). In October 2006, the UN Security Council imposed an arms embargo, as well as other sanctions, upon the Democratic People's Republic of Korea (North Korea). According to Frank (2006), these sanctions are partly meant to restore the balance of power between North Korea and the Republic of Korea (South Korea) by making it more difficult (i.e. more expensive) for the former country to arm.

The issues discussed in our paper are closely related to a recent contribution by Gershenson (2002) on sanctions and civil conflict. Gershenson systematically examines the effect of sanctions on civil conflict when two rival parties compete for control of economic rents. In our analysis, we examine outside intervention intended to raise the cost of rebellion in a target state. In terms of modeling outside intervention, our analysis departs from Gershenson's in some important aspects. Foremost, in our setting the third party acts to maximize its expected payoff with respect to the target state.⁷ Hence, in characterizing the endogeneity of outside intervention, our paper addresses both the role and scope of biased third-party intervention. However, the two studies share an important analytical feature. By adopting a Stackelberg or

⁶ A rebel's level of motivation is taken to vary with the degree to which it can derive value from state control.

⁷ As previously emphasized, a third party's expected payoff may incorporate humanitarian interests in addition to strategic and economic considerations.

sequential game approach in characterizing the outcome of civil conflict, both studies are capable of analyzing explicitly issues on engagement and deterrence.

The analytical framework presented in this paper complements recent contributions by Amegashie and Kutsoati (2007) and Chang *et al.* (2007b). The present study differs in some important aspects. First, Amegashie and Kutsoati analyze third-party intervention when two warring factions play a simultaneous-move game. We follow Gershenson and Grossman (2000) and Chang *et al.* (2007b) to analyze third-party intervention in a setting in which two rival parties play a sequential-move game. Second, unlike Chang *et al.* (2007b), who study a third party that acts to lower the marginal cost of an allied party's efforts in conflict, we study cost-raising intervention on the part of a biased third-party in an intrastate conflict. This is a distinct mode of intervention that merits separate treatment. It has been documented that the suppression of rebels by outside intervention constitutes an effective option in reducing social damages by insurrection. Given the empirical evidence, Azam *et al.* (2001: 1) conclude, 'International policies for conflict reduction should therefore be aimed at increasing the cost of rebellion and at reducing the revenues from it.' Based on this conclusion, we wish formally to model and characterize aspects of 'raising rival's costs' through third-party intervention within a three-stage game of conflict.

It is important to note that there are potential distinctions between the magnitude and effect of proactive third-party intervention and reactive third-party intervention in general. Although the technology for these two types of intervention is the same within our model, as in Chang *et al.* (2007b), one must ask what type of third party would become involved during the course of a conflict. Within the model, the third party bases its intervention decision upon parametric values held by the two primary parties. In a dynamic model, one would think of these values as positively autocorrelated for a given party (i.e. the rebel's effectiveness in a given period is positively related to its effectiveness in the previous period). The alternative assumptions are that party strength in a period has nothing to do with party strength in the previous period or that party strength in a period is negatively impacted by party strength in the previous period. Given the presumption of positive autocorrelation, the third party's optimal intervention decision would not, for the most part, change drastically from period to period. That is, if the third party chose not to become involved in the initial periods of a conflict, it is more likely to stay out of the conflict entirely and less likely to intervene at a deterrent level amidst conflict. If the third party does become involved in a reactive fashion, we would expect it to do so only marginally. Anything more would constitute a drastic leap from the third party's original non-intervention policy and would thus require an equally drastic shock in the relevant characteristics of the conflict. In other words, we expect the risks and values associated with intervention to be persistent (i.e. a risky conflict remains, to a large degree, a risky conflict). As sub-deterrent interventions, by definition, are not expected to shorten the duration of conflict (as do deterrent interventions), this reasoning supports the conclusion that intervention amidst conflict is unlikely to carry the goal of conflict management (i.e. likely to fit the Balch-Lindsay and Enterline view of intervention). Throughout the reading, one should note that intervention objectives may be different for the proactive intervener, as compared to the reactive one, although their technologies of intervention are taken as the same. Further, a rebel's relative strength, as captured by the conflict parameters, can change in conflict.⁸

⁸ Similarly, we would expect the rebel to be distinct, on average, in an ongoing rebellion, as compared to a potential rebellion, in that the former has certainly avoided initial deterrence. Tautologically, less easily deterred rebels will become engaged in conflict and will survive longer in conflict, *ceteris paribus*. Indeed, Mason *et al.* (1999) find that rebel deterrence becomes less likely as a rebellion matures. Within our model, such heterogeneity would be accounted for in the parametric values that determine rebel and incumbent government characteristics.

The remainder of the paper is structured as follows. The next section develops a sequential game framework of intrastate conflict, taking into account the presence of third-party intervention in raising the cost of rebellion. The third section examines the optimizing behavior of the intervening third party to analyze the endogeneity of rebel-suppressing third-party intervention. In this section, we further present policy implications of the model. The fourth section summarizes and concludes.

THE MODEL

Timing of a Three-stage Game and ‘Intervention Technology’ of a Third Party

We consider a scenario in which two rival parties, an incumbent government and rebel group, are in a situation of potential or realized intrastate conflict.⁹ In other words, there exists an incumbent government and a rebel group, each of whom value control of the state or a sub-region of the state. However, the rebel group can achieve control of the target region only by wresting it from the incumbent government. To examine the scope and incentive of third-party intervention, we assume that there is a ‘biased’ third party who prefers the status quo and supports the incumbent government in retaining power over the state.

We model a three-stage game that constitutes a single decision period in a potential or realized intrastate conflict.¹⁰ The timing of the game is as follows. The third party moves first in expending effort to raise the cost of rebellion, taking into account the impact of its actions in the subsequent sub-games played between the government and rebel group. In the second stage of the three-stage game, the government, as defender, moves before the rebel group in determining its defensive military spending allocation. The rebel group, as challenger, moves at the third and final stage of the overall game played among the three parties. The methodological advantage of this game is twofold. First, it extends the Gershenson–Grossman (2000) framework of conflict in a two-stage game to the case involving an intervening third party in a three-stage game.¹¹ As a result, we are able to characterize explicitly the endogeneity of third-party intervention in raising the cost of rebellion. Second, this sequential game approach allows for the analysis of a deterrence strategy on the part of the defender.

To analyze rebel-suppressing third-party intervention in intrastate conflict, it is necessary to discuss the term ‘intervention technology’. This term reflects the extent to which the third party can affect the capability of the rebel group and, in so doing, affect the overall outcome

⁹ By the term ‘potential intrastate conflict’, it is meant that a state lies under the shadow of conflict or armed confrontation. Several theoretical models describing interstate conflict, including Gershenson and Grossman (2000), and Chang *et al.* (2007a), adopt the same starting point. Gershenson (2003) and Chang *et al.* (2007b) study third-party efforts to reduce an ally’s unit cost of arming under the shadow of conflict.

¹⁰ A decision period may begin under the shadow of conflict (potential intrastate conflict) or amidst ongoing conflict (realized intrastate conflict). Thus, a third-party may be proactive (i.e. act in the shadow of conflict) or reactive (i.e. act amidst violence) within the scope of the model. There are examples of both types of intervention in practice. As an example of proactive intervention, the United Nations currently enforces a targeted arms embargo against non-state actors in Liberia despite general adherence to a 2003 peace agreement in the country. Thus, the United Nations is effectively raising rebel costs in the shadow of potential future conflict. However, these same UN sanctions, when originally imposed in 1992, were in reaction to ongoing conflict in Liberia.

¹¹ In the game’s second and third stages, we also follow Grossman and Kim (1995) and others after them in utilizing a Stackelberg framework in which the defender leads in determining its defensive allocation of military goods. Gershenson (2002) defends this structure by assuming that the incumbent’s institutional framework is relatively rigid; therefore, defensive allocations constitute a commitment on the part of the incumbent. Chang *et al.* (2007a) develop a model to characterize possible outcomes of a land dispute between two rival parties in a Stackelberg game. More generally, and perhaps more fundamentally, Leininger (1993) shows, in an interesting rent-seeking model, that players are expected to engage in a sequential-move game. Morgan (2003) further uses a sequential-move game to examine the possibility of asymmetric contests for uncertain realizations of values to rival competitors.

of the potential or realized conflict. Given its preference for the status quo (i.e. that the incumbent government maintains state control), the third party we examine considers an intervention effort on behalf of the incumbent government.¹² Should the third party decide to intervene, we assume that it does so indirectly by expending effort to raise the costs of insurrection. Denote such a cost-raising effort as M , which enters into the rebel's military cost function, $C_r = f(M)R$ such that $f'(M) > 0$ and $f''(M) < 0$.¹³ That is, other things being equal, an increase in M raises the cost of arming for rebellion, and this cost-raising effect is subject to diminishing returns. Also, we assume that $f(M) = 1$ when $M = 0$. That is, the rebel group's military cost is unaffected in the absence of outside intervention.

We will examine how the third-party's intervention technology interacts with the respective conflict technologies of the contending parties to determine whether rebellion ensues and, if so, to what degree.

Equilibrium of Intrastate Conflict (given Rebel-suppressing Third-party Intervention)

As in game theory, we use backward induction to determine the sub-game perfect Nash equilibrium of the three-stage game. We first characterize the equilibrium of interstate conflict, given the third-party's rebel-suppressing intervention effort at the first stage of the game. We then determine the optimal level of intervention by the third party.

Following the conflict literature, we use a canonical 'contest success function' to capture the technology of conflict. Specifically, the probabilities that the government and rebel group will succeed in armed confrontation are given respectively by:

$$p_g = \frac{G}{G + \mu R} \text{ and } p_r = \frac{\mu R}{G + \mu R} \quad (1)$$

where p_g represents the likelihood that the government remains politically dominant over the decision period, p_r is the likelihood that the rebel group becomes politically dominant during the period, G measures the amount of military defense spending the incumbent government allocates at the beginning of the period; R measures the amount of military spending the rebel group allocates to challenge for the state or for a sub-region of the state at the beginning of the period; μ represents the relative effectiveness of a unit of rebel military spending to a unit of government military spending.¹⁴

The probabilities of success specified above are in a simple additive form of conflict technologies. According to Garfinkel and Skaperdas (2007), a wide class of additive form contest success functions (CSFs) has been utilized in many fields of economics. They further indicate one important characterization associated with these CSFs, which is referred to as the *Independence of Irrelevant Alternatives* property. Specifically, Garfinkel and Skaperdas (2007: 655) remark that: 'In the context of conflict, this property requires that the outcome of conflict between any two parties depend only on the amount of guns held by these two parties and not on the amount of guns held by third parties to the conflict.' This property suggests that

¹² Within the model's framework, we find this preference to be a necessary but not sufficient condition for such an intervention to take place.

¹³ We thank an anonymous referee who suggests that we use the more general function for the costs of the rebel group to reflect the technology of third party intervention.

¹⁴ Note that each party's likelihood of victory is equal to the effectiveness of its military goods allocation divided by the aggregated effectiveness of the military goods allocation for the two primary parties. For discussions on alternative forms of contest success functions, see, for example, Tullock (1980), Hirshleifer (1989), Skaperdas (1996), Garfinkel and Skaperdas (2007), and Konrad (2007).

third parties have no ‘direct’ effect in a two-party conflict for an additive form of conflict technology. It is easy to verify that this statement is valid for the case in which the two conflicting parties determine their optimal amounts of guns in a simultaneous-move game. Interestingly, in the three-stage sequential game we consider, an intervening third party has an important role in affecting the equilibrium outcome of the two conflicting parties, despite the additive form of conflict technologies in equation (1).

Given that the third party invests M toward raising the cost of rebellion at stage one, the payoff functions for the incumbent government and rebel group in the subsequent stages of the game are given respectively by:

$$Y_g = \left(\frac{G}{G + \mu R} \right) V_g - G \quad (2a)$$

$$Y_r = \left(\frac{\mu R}{G + \mu R} \right) V_r - f(M)R \quad (2b)$$

where $M \geq 0$ represents the third party’s level of investment in policies that act to raise the cost of rebellion (i.e. enforcement of targeted arms sanctions); V_g and V_r are, respectively, the total values that the government and rebel group attach to political dominance for a period, where a party can value political dominance for economic and deep intrinsic reasons.¹⁵

Within the model, each of the primary parties chooses a level of military spending to maximize its expected payoff. Consistent with backward induction in game theory, we begin with the game’s last stage to analyze the rebel group’s optimization problem. Namely, the rebel group chooses its investment in military goods to challenge for control of the disputed state or sub-state through armed confrontation.

Given the defensive military goods allocation (G) by the government in stage two, the rebel group’s optimal expenditure on military goods in the last stage satisfies the following Kuhn–Tucker conditions:

$$\frac{\partial Y_r}{\partial R} = \left[\frac{\mu G}{(G + \mu R)^2} \right] V_r - f(M) \leq 0; \frac{\partial Y_r}{\partial R} < 0 \text{ if } G = 0 \quad (3)$$

From equation (3), we solve for the rebel’s best-response function in terms of G and the parameters:

$$R(G) = \frac{\sqrt{G}}{\mu} \left[\sqrt{\frac{\mu V_r}{f(M)}} - \sqrt{G} \right] \geq 0 \text{ if } 0 \leq G \leq G_1 \quad (4)$$

where G_1 represents the incumbent government’s minimum level of expenditure on arming for effective deterrence. That is,

$$R = 0 \text{ when } G \geq G_1, \text{ where } G_1 = \frac{\mu V_r}{f(M)} \quad (5)$$

¹⁵ When there is no outside intervention such that $M = 0$, the three-country, three-stage model reduces to a two-country, two-stage model such as those examined in Gershenson and Grossman (2000), Grossman (2004), and Chang *et al.* (2007a).

For the case in which $G \geq G_1$, the rebel group finds it optimal to refrain from arming for attack, and there is no armed confrontation between the two parties in the period.¹⁶ But if $G < G_1$, the rebel group chooses a positive amount of arming, and armed confrontation ensues. It follows from equation (4) that the slope of the rebel group's best-response function is:

$$\frac{dR(G)}{dG} = \frac{1}{2} \sqrt{\frac{V_r}{\mu f(M)G}} - \frac{1}{\mu} \quad (6)$$

which can be greater than, equal to, or less than zero. Define G_0 as the value of G at which the rebel group's best-response function has a zero slope, i.e. $dR(G)/dG = 0$. It is easy to verify

$$\text{that } G_0 = \frac{\mu V_r}{4f(M)} = \frac{G_1}{4}.$$

It is instructive to use a graphical approach to explicitly characterize the nature of the rebel group's best-response function. As illustrated in Figure 1, the value of $R(G)$ tends toward zero as the value of G tends toward zero. For values of G large enough so that $R(G) \leq 0$, the rebel group optimally chooses $R^* = 0$, and there is 'perfect deterrence'. Between $G = 0$

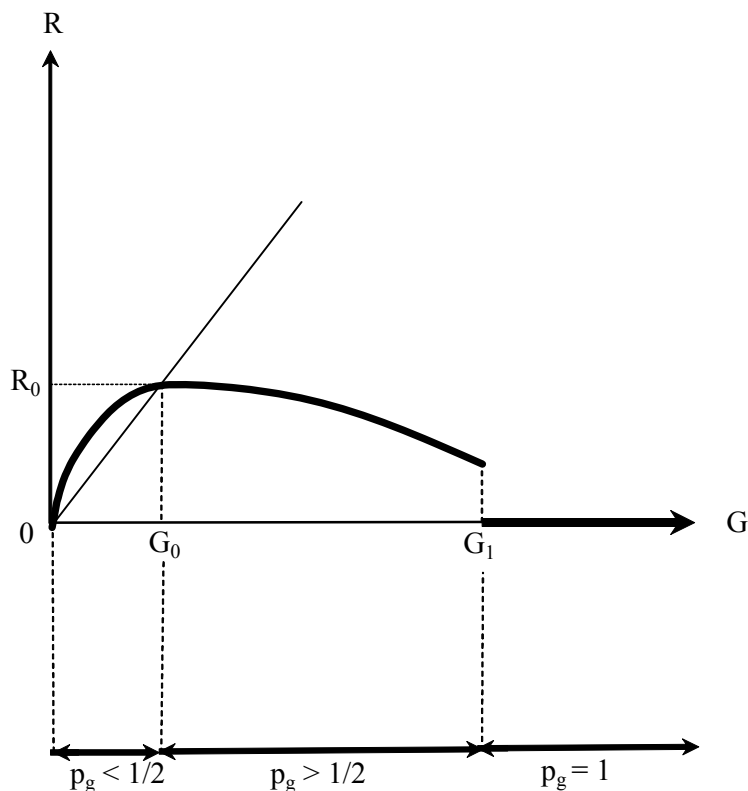


FIGURE 1 The rebel group's best-response function and the government's probability of success

¹⁶ Several Stackelberg models of civil conflict utilize this deterrence condition. See, for example, Gershenson and Grossman (2000).

and $G = G_1$ the value of $R(G)$ initially increases $\left(\text{for } G < G_0 = \frac{1}{4}G_1 \right)$ and then decreases $\left(\text{for } G > G_0 = \frac{G_1}{4} \right)$. The ‘cutoff point’ is $G_0 = \frac{\mu V_r}{4f(M)} = \frac{G_1}{4}$. The equilibrium outcome depends on whether we are along the ‘increasing portion of $R(G)$ ’ or along the ‘decreasing portion of $R(G)$ ’, that is whether the government’s optimal arming (denoted as G^*) is such that $G^* < \frac{\mu V_r}{4f(M)}$ or $G^* > \frac{\mu V_r}{4f(M)}$. We show in Figure 1 that there is a straight line from the origin through the point of $(G_0, R_0) = \left(\frac{G_1}{4}, \frac{G_1}{4\mu} \right)$. By the strict concavity of $R(G)$, it follows that the best-response function is above the straight line for $G < G_0 \left(= \frac{G_1}{4} \right)$ and below the straight line for $G > G_0 \left(= \frac{G_1}{4} \right)$. As will be shown in the subsequent analysis, the ‘cutoff’ G_0 affects the government’s probability of success when $G < G_1$ and $R > 0$.

For the case where $G < G_1$ and $R > 0$, we have from the Kuhn–Tucker conditions in equation

(3) that $G + \mu R = \sqrt{\frac{\mu V_r G}{f(M)}}$. It follows that $p_g \left(= \frac{G}{G + \mu R} \right)$ in equation (1) becomes

$$p_g = \left(\sqrt{G} \right) \left(\sqrt{\frac{f(M)}{\mu V_r}} \right). \text{ It is easy to verify that } p_g \text{ is less than } 1/2 \text{ above this straight line (where}$$

$G < G_0$), but *greater* than $1/2$ below this straight line (where $G > G_0$). In other words, there are qualitatively two different cases of equilibria with $R^* > 0$:

Case (i): those with $G^* < \frac{\mu V_r}{4f(M)}$, in which a slight increase in G would cause the rebel group to choose a larger value of R and the equilibrium value of p_g is $p_g < 1/2$ (that is, in equilibrium the rebel group is likely to gain political dominance);

Case (ii): those with $G^* > \frac{\mu V_r}{4f(M)}$, in which a slight increase in G would cause the rebel group to choose a smaller value of R and the equilibrium value of p_g is $p_g > 1/2$ (that is, in equilibrium the government is likely to maintain political dominance).

The next step is to determine the optimizing problem of the government at the second stage of the three-stage game. Substituting $G + \mu R = \sqrt{\frac{\mu V_r G}{f(M)}}$ into the payoff function of the government in equation (2a) yields:

$$Y_g = V_g \sqrt{\frac{f(M)G}{\mu V_r}} - G \quad (7)$$

The objective of the government is to choose G that satisfies the FOC as follows:

$$\frac{\partial Y_g}{\partial G} = \frac{V_g}{2} \sqrt{\frac{f(M)}{\mu V_r G}} - 1 = 0 \quad (8)$$

Solving equation (8) for the government's optimal allocation of defensive military spending yields:

$$G^* = \frac{f(M)V_g^2}{4\mu V_r} \quad (9)$$

Substituting $G^* = \frac{f(M)V_g^2}{4\mu V_r}$ from equation (9) into the inequality conditions in cases (i) and (ii) and rearranging terms, we have:

$$\text{Case (i): } p_g < \frac{1}{2} \text{ if } G^* < \frac{\mu V_r}{4f(M)} \text{ and } f(M) < \frac{\mu V_r}{V_g} \quad (10a)$$

$$\text{Case (ii): } p_g > \frac{1}{2} \text{ if } G^* > \frac{\mu V_r}{4f(M)} \text{ and } f(M) > \frac{\mu V_r}{V_g} \quad (10b)$$

Thus, other things being equal, the qualitatively different nature of the equilibrium outcome in these two distinct cases depends on G^* , as well as on the level of third-party intervention in raising the cost of rebellion, $f(M)$, relative to the ratio of the rebel group's value of political dominance over that of the incumbent government modified by the rebel's relative military effectiveness, $\mu \frac{V_r}{V_g}$.

To determine the optimal level of arming by the rebel group, we substitute G^* in equation (9) into R in equation (4) to obtain:

$$R^* = \frac{V_g}{2\mu} \left[1 - \frac{f(M)V_g}{2\mu V_r} \right] \quad (11)$$

If the government's optimal expenditure on military goods at least equals the deterrent level, i.e. $G^* \geq G_1$ the rebel group's optimal level of arming for attack becomes $R^* = 0$. It follows from equations (5), (9), and (11) that the necessary and sufficient condition for perfect deterrence is:

$$\frac{f(M)V_g^2}{4\mu V_r} - \frac{\mu V_r}{f(M)} \geq 0 \quad (12)$$

Condition (12) is consistent with the following inequality:

$$f(M) \geq \frac{2\mu V_r}{V_g} \quad (13)$$

which is derived by setting $R^* = 0$ in equation (11). As in the literature, we characterize this equilibrium as one in which there is no armed confrontation between government and rebel group. The incumbent government maintains state control without challenge.

If, however, condition (12) is violated, then the rebel group arms to confront the incumbent government. This outcome occurs when:

$$\frac{f(M)V_g^2}{4\mu V_r} - \frac{\mu V_r}{f(M)} < 0 \quad (14)$$

This condition is consistent with the following inequality:

$$f(M) < \frac{2\mu V_r}{V_g} \quad (15)$$

which is derived by setting $R^* > 0$ in equation (11).

It is clear from R^* in equation (11) that if the value of M chosen by the third party satisfies $M \geq \hat{M} > 0$, where \hat{M} is defined as the critical level of intervention effort that satisfies the following condition:

$$f(\hat{M}) = \frac{2\mu V_r}{V_g}$$

The third party deters a rebellion that would otherwise have occurred. The left-hand side inequality ($M \geq \hat{M}$), which follows from equation (12), says that the third party meets the critical level of intervention to deter rebellion. The right-hand side says that this critical level is positive ($\hat{M} > 0$). In other words, the latter inequality ensures that armed confrontation would have ensued in the absence of intervention.

However, if the value of M chosen by the third party satisfies $\hat{M} > M > 0$, the third party intervenes at a sub-deterrent level. That is, the third party intervenes without the intent of deterring rebellion when such an opportunity exists. The motivation for sub-deterrent intervention is simply to improve the incumbent government's potential to succeed (i.e. to maintain power) in conflict.

Given that M is determined by the third party, it is instructive to see the marginal effects of a change in M on G^* and R^* . From equations (9) and (11), it follows that:

$$\frac{\partial G^*}{\partial M} > 0 \text{ and } \frac{\partial R^*}{\partial M} < 0 \quad (16)$$

These findings allow us to establish the following proposition.

Proposition 1

In an intrastate conflict involving an incumbent government and a rebel group, the involvement of a third party in raising the cost of rebellion enhances the level of military defense on the part of the incumbent government, other things being equal. Moreover, this cost-raising intervention unambiguously reduces the scale of military challenge by the rebel group, *ceteris paribus*.

Given the level of cost-raising intervention effort by the third party at stage one of the game, the government's optimal expenditure on defensive weapons increases with its value of political dominance, but decreases with the rebel group's value of political dominance and the group's relative military effectiveness. If the government's optimal amount of military allocation is critically lower (higher) than the 'cutoff value', other things being equal, the probability that the government will succeed in the intrastate conflict is less (greater) than 50%.

Using G^* , R^* , and the CSFs in equation (1), we calculate the probabilities of success for the government and rebel group as follows:

$$p_g = \frac{f(M)V_g}{2\mu V_r} \text{ and } p_r = 1 - \frac{f(M)V_g}{2\mu V_r} \quad (17)$$

It becomes straightforward from equation (17) that whether $p_g < 1/2$ or $p_g > 1/2$ depends crucially on whether $f(M) < \frac{\mu V_r}{V_g}$ or $f(M) > \frac{\mu V_r}{V_g}$. We thus have shown that third-party

intervention also plays a role in affecting the government's probability of success in retaining its political dominance. Further, the marginal effects of a change in M on the primary parties' probabilities of success are:

$$\frac{\partial p_g}{\partial M} > 0 \text{ and } \frac{\partial p_r}{\partial M} < 0$$

These analytical findings lead to the following proposition.

Proposition 2

In an intrastate conflict involving an incumbent government and a rebel group, the involvement of a third party in raising the cost of rebellion increases the probability that the government will succeed in the intrastate conflict. The rebel-suppressing third-party intervention has a negative effect on the probability of success for the rebel group.

Within our model, intervention is unambiguously effective in raising the likelihood of a favorable conflict result, as viewed from the perspective of the third party. One important issue remains concerning the conditions under which a third party intervenes in an intrastate conflict. This leads us to examine the incentives of third-party intervention.

THE ENDOGENEITY OF THIRD PARTY INTERVENTION

In this section, we go to the first stage of the three-stage game to examine optimal intervention by the third party. There are potential benefits to a third party should the government retain its political dominance. Denote S_g as the value the third party will derive should the government remain politically dominant over the decision period. As stated in the Introduction of the paper, this value may derive from enhanced access to trade and natural resources, improved national security, ethical fulfillment, and geo-strategic advantage. Let S_r represent the value the third party will obtain should the rebel group achieve political dominance in the decision period. We assume that $S_g > S_r \geq 0$, i.e. the third party will be better off if the government maintains political dominance. As Werner (2000) states, 'One important reason for involvement is often the third party's perception that the attacking country poses a significant threat to the status quo.' Within our analysis, this motivational threat is represented by the term $(S_g - S_r)$.

It is postulated that the objective of the third party is to maximize its expected benefit with respect to the disputed state, net of its effort in raising the cost of rebellion. Specifically, this payoff function for the third party is taken as $Y_t = p_g S_g + p_r S_r - M$. Substituting the probabilities of success in equation (17) into the payoff function yields:

$$Y_t = \left[\frac{f(M)V_g}{2\mu V_r} \right] S_g + \left[1 - \frac{f(M)V_g}{2\mu V_r} \right] S_r - M$$

The objective of the third party is to choose an optimal intervention that satisfies the following Kuhn–Tucker conditions:

$$\frac{\partial Y_t}{\partial M} = \frac{f'(M)V_g(S_g - S_r)}{2\mu V_r} - 1 \leq 0 \quad (18a)$$

$$\frac{\partial Y_t}{\partial M} < 0 \text{ if } M = 0 \quad (18b)$$

It follows that:

$$\frac{\partial Y_t}{\partial M} < 0 \text{ if } f'(M) < \frac{2\mu V_r}{V_g(S_g - S_r)} \quad (19)$$

In this case, the best decision for the third party is no intervention ($M^* = 0$). The sufficient condition under which the third party has an incentive to allocate the first dollar to intervention is:

$$f'(M)|_{M=0} > \frac{2\mu V_r}{V_g(S_g - S_r)} \quad (20)$$

That is, the marginal effectiveness in raising the cost of rebellion, when evaluated at $M = 0$, is strictly positive. This sufficient condition, equation (20), for an intervention decision is more likely to hold the greater the ratio of V_g over V_r , the higher the value of S_g , the lower the value of S_r , and the lower the value of μ , *ceteris paribus*.

For the purpose of illustration, we assume that $f(M) = (1 + M)^\theta$, where θ measures the effectiveness of the intervention technology in raising the costs of rebellion and $0 < \theta < 1$. Note that this particular functional form satisfies the previous assumption on, and properties of, the more general class of functions $f(M)$. It follows from the Kuhn–Tucker conditions that:

$$\frac{\partial Y_t}{\partial M} < 0 \text{ if } \theta(1 + M)^{\theta-1} < \frac{2\mu V_r}{V_g(S_g - S_r)}$$

Stated alternatively:

$$\frac{\partial Y_t}{\partial M} < 0 \text{ if } 0 < S_g < \tilde{H} + S_r \quad (21)$$

where $\tilde{H} = \frac{2\mu V_2(1 + M)^{1-\theta}}{V_1\theta}$. In this case, $M^* = 0$. Given these results, we have the following proposition.

Proposition 3

The third party finds it optimal not to intervene when the additional value it derives from the incumbent government holding power is ‘critically low.’ In other words, the sufficient condition for intervention (equation (19) or (21)) becomes less likely as S_g increases or S_r decreases. This non-intervention inequality becomes more likely to hold as the rebel group’s relative value for political dominance increases or as the rebel group’s relative military spending effectiveness increases. Thus, in its intervention decision, the third party treats the incumbent government’s relative military effectiveness and relative value for political dominance as complementary to its own efforts.

Proof

For the proof, see A-1 in the Appendix.

A third party will intervene to raise the marginal cost of rebellion only when it places sufficient value on political dominance by the state’s incumbent government, as compared with

political dominance by the state's rebel group. The complementarity discussed in Proposition 3 above exists because intervention efforts are more marginally effective in restraining a rebellion that is relatively ineffective militarily or one that is relatively unmotivated, *ceteris paribus*. That is, the third party's intervention technology endogenously interacts with the respective conflict technologies in an indirect manner such that intervention is more marginally effective in reducing p_r^* for such a rebellion. The implication is that intervention efforts function as matching funds within the model, whereby a third party is more apt to help those that are willing and able to help themselves.

To examine the implications of an optimal third-party intervention, we assume that S_g is sufficiently high in value that the necessary condition for maximizing the expected payoff, $\frac{\partial Y_t}{\partial M} = 0$, has an interior solution. In this case, we have from equation (18a) that:

$$f'(M^*) = \frac{2uV_r}{V_g(S_g - S_r)} \quad (22)$$

where M^* denotes the optimal level of rebel-suppressing intervention. Using the optimality condition in equation (22), we present a comparative statics analysis on M^* as follows:

$$\frac{\partial M^*}{\partial S_g} = -\frac{f'(M^*)}{(S_g - S_r)f''(M^*)} > 0 \quad (23a)$$

$$\frac{\partial M^*}{\partial S_r} = \frac{f'(M^*)}{(S_g - S_r)f''(M^*)} < 0 \quad (23b)$$

$$\frac{\partial M^*}{\partial V_g} = -\frac{f'(M^*)}{f''(M^*)} > 0 \quad (23c)$$

$$\frac{\partial M^*}{\partial V_r} = \frac{2\mu}{V_g(S_g - S_r)f''(M^*)} < 0 \quad (23d)$$

$$\frac{\partial M^*}{\partial \mu} = \frac{2V_r}{V_g(S_g - S_r)f''(M^*)} < 0 \quad (23e)$$

It follows from equation (17) that the sub-game perfect Nash equilibrium value for the government's probability of success is $p_g^* = \frac{f(M^*)V_g}{2\mu V_r}$, where $M^* = M^*(S_g, S_r, V_g, V_r, \mu)$ with the associated derivatives in equation (23a)–(23e). The comparative statics analysis on p_g^* is presented as follows:

$$\frac{\partial p_g^*}{\partial S_g} = \frac{V_g f'(M^*)}{2\mu V_r} \frac{\partial M^*}{\partial S_g} > 0 \quad (24a)$$

$$\frac{\partial p_g^*}{\partial S_r} = \frac{V_g f'(M^*)}{2\mu V_r} \frac{\partial M^*}{\partial S_r} < 0 \quad (24b)$$

$$\frac{\partial p_g^*}{\partial V_g} = \frac{1}{2\mu V_r} \left[V_g f'(M^*) \frac{\partial M^*}{\partial V_g} + f(M^*) \right] > 0 \quad (24c)$$

$$\frac{\partial p_g^*}{\partial V_r} = -\frac{f(M^*)V_g}{2\mu V_r^2} + \frac{V_g f'(M^*)}{2\mu V_r} \frac{\partial M^*}{\partial V_r} < 0 \quad (24d)$$

$$\frac{\partial p_g^*}{\partial \mu} = -\frac{f(M^*)V_g}{2\mu^2 V_r} + \frac{V_g f'(M^*)}{2\mu V_r} \frac{\partial M^*}{\partial \mu} < 0 \quad (24e)$$

where equations (23a)–(23e) are used to sign the derivatives in equations (24a)–(24e). It is straightforward to show that these parameters have an opposite effect on the probability of success for the rebel group.

Using the special function $f(M) = (1+M)^\theta$ discussed above as an illustrated example, we derive the closed-form solution for the optimal level of intervention:

$$\hat{M} = \left[\frac{\theta(S_g - S_r)V_g}{2\mu V_r} \right]^{\frac{1}{1-\theta}} - 1 \quad (25)^{17}$$

Note that:

$$\hat{M} > 0 \text{ if and only if } \frac{\theta(S_g - S_r)V_g}{2\mu V_r} > 1 \quad (26)$$

It is easy to verify that:

$$\frac{\partial \hat{M}}{\partial S_g} > 0; \frac{\partial \hat{M}}{\partial S_r} < 0; \frac{\partial \hat{M}}{\partial V_g} > 0; \frac{\partial \hat{M}}{\partial V_r} < 0; \frac{\partial \hat{M}}{\partial \mu} < 0; \frac{\partial \hat{M}}{\partial \theta} > 0 \quad (27)$$

According to equation (17), the government's probability of success in equilibrium is:

$$\hat{p}_g = \frac{f(\hat{M})V_g}{2\mu V_r} = \frac{(1 + \hat{M})^\theta V_g}{2\mu V_r}$$

where \hat{M} is given by equation (25). It is also easy to verify that:

¹⁷ See A-2 in the Appendix for a detailed derivation of the optimal intervention level.

$$\frac{\partial \hat{p}_g}{\partial S_g} > 0; \frac{\partial \hat{p}_g}{\partial S_r} < 0; \frac{\partial \hat{p}_g}{\partial V_g} > 0; \frac{\partial \hat{p}_g}{\partial V_r} < 0; \frac{\partial \hat{p}_g}{\partial \mu} < 0; \frac{\partial \hat{p}_g}{\partial \theta} > 0 \quad (28)$$

The positive signs for the derivatives of \hat{M} and \hat{p}_g with respect to θ deserve particular attention. They imply that the optimal level of intervention and the government's probability of success will increase as the impact of intervention on the rebel's cost becomes greater.

Based on the findings, we have Proposition 4.

Proposition 4

In an intrastate conflict between an incumbent government and a rebel group, the optimal level of third party intervention in raising the cost of rebellion increases with the strategic value to the third party when the government retains power (S_g), decreases with the strategic value to the third party when the rebel group acquires power (S_r), increases with the government's intrinsic value (V_g), decreases with the rebel's intrinsic (V_r) and decreases with the rebel group's military effectiveness (μ) *ceteris paribus*. Further, the optimal level of intervention increases if the impact of intervention on the rebel's costs (as captured by θ) is greater. Consequently, the government's probability of success in retaining political dominance increases in S_g , increases in V_g , increases in θ , decreases in S_r , decreases in V_r , and decreases in μ .

Proposition 4 leads us to conclude that an increase in the strength of inter-governmental trade partnerships increases the level of third-party intervention and thus the likelihood that intervention acts to deter a rebellion. This finding derives from the fact that S_g increases as an incumbent government provides better access to trade, *ceteris paribus*. Barbieri and Reuveny (2005) conclude that 'economic forms of globalization reduce the likelihood of civil war', where globalization is measured partly by legal trade flows. Our paper is consistent with this finding in predicting that an increase in legitimate trade flows would increase the likelihood of third-party intervention on behalf of the incumbent government, which would, in turn, increase the likelihood of rebel deterrence in the shadow of intrastate conflict.

There is a vast literature, primarily within the political science paradigm, that questions the effectiveness of economic sanctions and other forms of intervention. Such papers often define an intervention effort as effective in the event that it creates a policy change that the intervener favors. Morgan and Schwebach (1997: 28) state, 'Most political science studies conclude that sanctions do not "work"... in the sense of bringing about a desired change in the policy of the target country.' However, our model shows that this policy change criterion appears to be invalid in measuring the success of third-party intervention. The third party we have specified could potentially bring about one type of policy change. In a given decision period, the third party may cause an incumbent government to deter effectively an active or mounting rebellion. In the second section, we find conditions in which the third party optimally chooses to intervene at a sub-deterrent level. In other words, the third party may purposefully intervene at a level insufficient to change incumbent government policy. It may do so simply to improve the incumbent government's potential to succeed (i.e. to maintain power) in conflict.

This result supports the Balch-Lindsay and Enterline view that intervention may not necessarily be intended to expedite an end to intrastate fighting. Rather, a third party can benefit in conflict as in the absence of conflict. Balch-Lindsay and Enterline (2000) state,

Regan (1996, 2000b) argues that third party interventions are intended, on average, to end an intrastate conflict as quickly as possible. However, other scholars counter that third parties intervene for less benevolent reasons,

including lengthening the duration of a civil war in order to distract, or drain the resources of, rival states, or simply to plunder the resources of the civil war state itself.

Such optimal third-party behavior calls into question the criterion by which the effectiveness of intervention is sometimes measured and is therefore relevant to any paper studying the effectiveness of sanctions or of intervention in general.

CONCLUDING REMARKS

In this paper, we use a standard game-theoretic model to analyze potential or realized conflict between an incumbent government and rebel party. Many important studies contribute to our understanding of intrastate conflict but do not allow for any form of outside intervention. There are a few models that do take into account third-party intervention or various forms of sanctions imposed by a third party. This is the first model, however, to consider an endogenous third party that intervenes by raising the cost of rebel movements, despite the practical import of this mode of intervention.

We incorporate third-party intervention explicitly into the Gershenson–Grossman (2000) model of intrastate conflict and find that raising the costs of the rebel movement reduces the level of rebellion in intrastate conflict. Further, the model reveals that raising the cost of rebellion reduces the likelihood that a rebellion is successful in wresting control from the incumbent government. The magnitude of these effects depends on the effectiveness of the intervention technology, the degree to which the third party values the status quo, and on the relative military spending effectiveness of the primary parties. Within the analysis, we find conditions in which third-party intervention is sufficient to deter an insurrection that would otherwise have occurred. However, it turns out that a third party in favor of the status quo in a state may optimally intervene at a level *insufficient* to deter rebellion. A third party may act in such a way simply to increase the likelihood that an incumbent government succeeds in conflict (i.e. maintains state control). Such optimal third-party behavior supports the Balch-Lindsay and Enterline view of third-party intervention. In terms of third-party objective, a successful intervention does not necessarily bring about policy change (i.e. deterrence of rebellion).

In characterizing biased third-party intervention, we also find that the third party treats an allied government's relative military effectiveness and relative value for political dominance as *complementary* to its own intervention efforts. It does so because intervention efforts are more marginally effective in restraining a rebellion that is relatively ineffective militarily or one that is relatively unmotivated, *ceteris paribus*. Lastly, given that access to trade affects third-party stakes in a conflict, we find that an increase in the strength of inter-governmental trade partnerships improves the likelihood that third-party intervention deters rebellion.

In closing, some caveats should be mentioned. To consider intervention and its effect on the duration of intrastate conflict, our simple sequential game framework could be modified to allow for a dynamic or repeated game. Another possible extension is to consider alternative intervention mechanisms implemented to suppress rebellion.¹⁸ Further, we do not consider the effect of intervention and destructive conflict upon the value of state control.¹⁹ Although

¹⁸ It should be noted that, for the analytical simplicity of the three-stage game, we have adopted many strong assumptions (on the additive forms of the CSFs, the cost functions of the primary parties, and the impact of third-party intervention on the costs of the rebel group). Possible extensions of the three-stage game-theoretic analysis include the use of a general contest success function such as $p_g(G, R)$ or a general function $C_r(R, M)$ for the military costs of the rebel group.

¹⁹ See, for example, Grossman (1992) and Chang *et al.* (2007a) for a discussion of such issues.

our analysis has interesting implications concerning the effect of inter-governmental trade partnerships on the possibility of outside intervention to suppress rebellion, we do not model endogenously the effect of international trade on *intrastate* conflict. This research topic, which parallels increasingly important studies concerning the effect of international trade on *interstate* conflict,²⁰ deserves further research attention.

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²⁰ For studies that examine trade and interstate conflict see, e.g., Polachek (1980, 1997), Reuveny and Maxwell (1998), Skaperdas and Syropoulos (1996, 2001), and Haaparanta and Kuisma (2005).

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APPENDIX

A-1. Complementarity between government defensive spending and third-party intervention efforts when $f(M)=(1+M)^\theta$

As the incumbent government's relative valuation for political dominance rises, other things being equal, the third party's marginal value of intervention rises. This is due to the fact that an increase in (V_g/V_r) will make a unit of M more effective in decreasing the likelihood of successful rebellion. That is, $\partial p_r / \partial M$ becomes more negative when (V_g / V_r) increases, as illustrated by the following derivative:

$$\frac{\partial}{\partial(V_g / V_r)} \left[\frac{\partial p_r}{\partial M} \right] = \frac{-\theta(1+M)^{\theta-1}}{2\mu} < 0 \quad (\text{A.1})$$

In the meantime, the increase in the incumbent government's relative valuation lowers the critical value of \tilde{H} , as shown by the following expression:

$$\frac{\partial \tilde{H}}{\partial(V_g / V_r)} = -\frac{2\mu V_r^2 (1+M)^{1-\theta}}{\theta V_g^2} < 0 \quad (\text{A.2})$$

It becomes more likely that the third party will decide to intervene. The results in equations (A.1) and (A.2) thus imply that an intervening third party treats the incumbent government's value for political dominance as complementary to its own intervention efforts.

Similarly, as the incumbent government's relative military spending effectiveness rises (i.e. μ decreases), a unit of M becomes more effective in decreasing the likelihood of successful rebellion. This is due to the fact that a decrease in μ causes $\partial p_r / \partial M$ to become more negative, as illustrated by the following derivative:

$$\frac{\partial}{\partial \mu} \left[\frac{\partial p_r}{\partial M} \right] = -\theta(1+M)^{\theta-1} \left(\frac{V_g}{2\mu^2 V_r} \right) > 0 \quad (\text{A.3})$$

In the meantime, the increase in the incumbent government's relative military spending effectiveness (i.e. the decrease in μ) lowers the value of \tilde{H} . This result can easily be verified by the following expression:

$$\frac{\partial \tilde{H}}{\partial \mu} = \frac{2V_r(1+M)^{1-\theta}}{\theta V_g} > 0 \quad (\text{A.4})$$

It becomes more likely that the third party will decide to intervene. The results in equations (A.3) and (A.4) thus imply that an intervening third party treats the incumbent government's relative military spending effectiveness as complementary to its own intervention efforts.

A-2. The optimal intervention level when $f(M) = (1+M)^\theta$

Substituting the contest success functions of the government and the rebel group into the third party's objective function, we have:

$$\begin{aligned}
U_t &= p_g S_g + p_r S_r - M \\
&= \left[\frac{(1+M)^\theta V_g}{2\mu V_r} \right] S_g + \left[1 - \frac{(1+M)^\theta V_g}{2\mu V_r} \right] S_r - M \\
&= \frac{(1+M)^\theta V_g}{2\mu V_r} (S_g - S_r) + S_r - M
\end{aligned}$$

Assuming that the value of S_g is sufficiently high such that there is an interior solution for M , the partial derivative of U_t with respect to M is:

$$\frac{\partial U_t}{\partial M} = \theta(1+M)^{\theta-1} \frac{(S_g - S_r)V_g}{2\mu V_r} - 1 = 0$$

which implies that:

$$(1+M)^{1-\theta} = \left[\frac{\theta(S_g - S_r)V_g}{2\mu V_r} \right] > 0$$

or that:

$$(1+M) = \left[\frac{\theta(S_g - S_r)V_g}{2\mu V_r} \right]^{\frac{1}{1-\theta}}$$

Solving for the optimal intervention level yields:

$$\hat{M} = \left[\frac{\theta V_g (S_g - S_r)}{2\mu V_r} \right]^{\frac{1}{1-\theta}} - 1$$

Note that:

$$\hat{M} > 0 \text{ if and only if } \frac{\theta(S_g - S_r)V_g}{2\mu V_r} > 1$$

The second-order sufficient condition for expected payoff maximization is satisfied at the interior solution because:

$$\frac{\partial^2 U_t}{\partial M^2} = \theta(\theta-1)(1+\hat{M})^{\theta-2} \frac{(S_g - S_r)V_g}{2\mu V_r} < 0$$