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# Conflict and Development

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**Abstract**

We examine a dynamic two-stage incumbent-challenger model of internal conflict, where the government, i.e. the incumbent, is in power, while the rebel challenges the government in a bid to capture state power. The central issue is the trade-off between development and security-based measures in countering such rebellion activity. We find that while an exogenous *increase* in development decreases the level of rebellion activity, it *increases* the level of security based measures by the government. Further, if the rebel is 'dominant' to begin with, then, with the rebel becoming stronger, the level of rebel activity increases, while the security based measures by the government is lowered. Finally, if the rebel becomes stronger (i.e. becomes more cost efficient), then the government might find it optimal to *decrease* the level of development. Thus our analysis suggests that the trade-off is a nuanced one.

**Key words**: Conflicts, development, rebel, contest success functions, difference-form.
**JEL Classification Number**: D72, D74, D78, H56.

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# 1 Introduction

Intra-country conflicts have been present and persistent across societies, cultures and countries. During the period 1960-2006, for example, twenty per cent of the countries have experienced at least ten years of conflicts with more than 1000 casualties per year (Blattman and Miguel, 2010). These conflicts are extremely costly, both in terms of human misery, as well as their impact on economic development. The impact on development is so serious that World Bank (2003) calls civil war 'development in reverse', finding that by "... the end of the typical civil war, incomes are around 15 per cent lower than they would otherwise have been, implying that about 30 per cent more people are living in absolute poverty."[1]

Interestingly, developing countries, in particular those in Latin America, Africa, Asia and the Middle East seem to be particularly prone to such conflicts (Karl DeRouen and Heo, 2007). One of our motivating examples comes from India, where the so called Maoist extremists has been rampant in several states, including Chhatishgarh, West Bengal, Orissa and Bihar, and, until recently, Andhra Pradesh.[2] The Indian sub-continent, including India, Pakistan, Sri Lanka and Nepal, has also been ravaged by many separatist movements.[3] Here we are interested in intra-country conflicts, which involves the government and a non-government group, with no interference from other countries.[4]

Not surprisingly, several empirical works have indeed found significant correlation between internal conflicts and underdevelopment (Blattman and Miguel, 2010). This suggests that development can be a possible tool for preventing, as well as fighting such conflicts (World Bank, 2003). In fact, it is sometimes argued that the tool of choice should be development, instead of tough measures

[1] In a similar vein Collier (1999) argues that "... during civil war countries tend to grow around 2.2 percentage points more slowly than during peace."

[2] Similar Maoist activities also caused a lot of bloodshed in Nepal.

[3] In India such separatist movements happened in the north-eastern states of Assam, Manipur and Nagaland. Sri Lanka has also experienced huge bloodshed and conflict on account of the Tamil separatist group LTTE. Pakistan is also facing many such problem particularly in Balochistan and Sindh provinces (Iyer, 2009).

[4] So, our analysis here does not focus on conflicts like Kashmir issue, as it essentially involves two countries, India and Pakistan.

involving the police and the military.[5] The annual report of the Ministry of Home Affairs, Government of India (2006-07) recognizes that "Naxalism is not merely a law and order problem; it has deep socio-economic dimensions."[6] In her review of government policies in the South Asian region, Iyer (2009) similarly categorizes these policies into two kinds, security-based approaches and politically accommodative steps (including economic policies). That such development can have strategic benefits is bourne out by the fact that in many countries, including India, rebels have been quite hostile to the development projects in the concerned areas.[7] They have regularly targeted and destroyed roads, bridges, rail-lines, schools, government buildings, etc. They have tried to stall infrastructure development projects.

Thus while dealing with the conflict problem, the security-based instruments and economic instruments (development) are the two major options open to the government. Given the real cost of such internal conflicts, it is of some importance to analyze the trade-offs between these two policy choices. In this paper we take a first cut in analyzing this issue.

We study this issue in a dynamic two-stage incumbent-challenger setup. The government is the incumbent, enjoying state power, while the rebel challenges the government in a bid to capture state power. The government first chooses the level of development. Subsequently, the rebel and the government simultaneously choose their level of activities, security-based measures for the government, and rebellion for the rebels. The success probability of the rebel and the government depends, in a natural fashion, on the level of development, as well their

[5]In a survey, conducted in some Maoist affected areas in India, a majority of people appears to be sympathetic to these rebels. They mostly disapprove the hard actions against these rebels (IMRB-TOI, 2010).

[6]In June 2013, at the Chief Ministers' Conference on Internal Security, the then Prime Minister of India, Manmohan Singh, had also mentioned that the Indian government had ".. adopted a two pronged strategy to deal with the challenge: conducting proactive and sustained operations against Maoist extremists; and, addressing development and governance issues in left wing extremism affected areas" (idsa, 2013).

[7]See these news reports: Satp (2009), OrissaPOST (2015), PTI (2010), HINDU (2013), Yadav (2014), and ANI (2011).

subsequent actions.

We begin by establishing conditions that an equilibrium exists, and is unique. We next analyze the impact of changes in the development level on the level of rebellion activity and security based measures. We uncover two effects that suggest that the argument that, development be used *instead of* tough measures, needs to be tempered. First, we show that while an exogenous *increase* in development leads to a decrease in the level of rebellion activity, it *increases* the level of security based measures by the government. Second, we find that if the rebel becomes stronger (i.e. becomes more cost efficient in rebellion), then the government might find it optimal to *decrease* the level of development.

Further, we demonstrate that if the rebel is 'dominant' to begin with (in a sense made formal later on), then, with the rebel becoming stronger, the level of rebel activity increases, while the security based measures by the government is lowered. If, however, the government is dominant to begin with, then there is an increase in rebel, as well as security based measures. This insight is quite general and is applicable to general conflict games as well.

We also perform several robustness checks. We demonstrate that the results go through qualitatively if one allows for the fact that the value of state power may be adversely affected by the conflict. Further, the results are robust to alternative specifications of the conflict success function, in particular the ratio form.

## 1.1 Related Literature

There is little or no work, either theoretical or empirical, that examine the role of development as a *policy tool* in fighting internal conflict. The empirical literature, succinctly surveyed by Blattman and Miguel (2010), does however demonstrate a a close correlation between the presence of internal conflicts and underdevelopment. The paper closest to our own work is Iyer (2009), who in her study of internal conflicts in South Asia, classifies governmental responses into two broad classes, (a) security based measures and (b) accommodative (economic, as well as political). *Inter alia*, she also demonstrates a tight correlation between underdevelopment and internal conflict.

There are some works which investigate the linkages between ethnicity and civil conflict, modelling civil conflicts as intergroup conflict (see Esteban and Ray (2011b), Esteban and Ray (2011a) and Esteban et al. (2012)). It shows that *polarization* and *fractionalization*, two measures of ethnic division, influence such conflicts. While in a different context, one of our results is similar to a result in Esteban and Ray (2011b). We find that the effect of the rebel becoming more cost efficient depends on whether the rebel is 'dominant' to begin with or not. Esteban and Ray (2011b) get a similar result while analyzing the effects of a group becoming more aggressive, on the equilibrium level of conflict.

# 2 The Model

The model comprises of two strategic players, the *government* and the *rebel*, who are locked in a conflict aimed at winning state power. The prize over which they fight, i.e. state power, is valued at $V$.[8]

In its effort at overthrowing the incumbent government, the rebel indulges in various rebellion activities, denoted by $R$. $R$ is interpreted broadly, so that it allows for *extra-constitutional* means, e.g. attacks on state forces (and possibly civilians), obstructing the functioning of state machinery, as well as *constitutional* ones, e.g. mobilizing public opinion against the state. The strategic options available to the government include security based measures (military/police deployment), denoted by $M$, as well as development works in the affected areas, denoted by $D$. Like $R$, $M$ is also broadly interpreted and includes military strikes against the rebels, enacting stricter laws, etc., as well as softer measures that include mobilizing public opinion.

We then introduce some notations:

Let $P(R, M)$ denote the probability of success of the rebel.

[8]We shall later consider the case where the effective value of the prize is decreasing in the 'extent' of conflict.

Let the rebel's cost function be denoted by $\zeta C^R(R, D)$, where $\zeta > 0$.[9]

Finally, the government's cost for security based measures is denoted by $C^M(M)$, and that for developmental activity is denoted by $C^D(D)$.[10]

We shall carry the following assumption throughout this paper.

*Assumption A1.*

(i) The contest success function $P(R, M)$ is twice differentiable with $P_R(R, M) > 0$, and $P_M(R, M) < 0$. Moreover, $P(R, M)$ is assumed to take the difference form, i.e $P(R, M) = {}^1\!/_{1+e^{M-R}}$ so that $P_{RR}(R, M) = P_{MM}(R, M) = -P_{RM}(R, M)$, and $P_{RM}(R, M) > 0$ if and only if $R > M$.[11]

(ii) $C^R(R, D)$ is twice differentiable. Further, it is increasing and convex in $R$, i.e. $C^R_R(R, D) > 0$ and $C^R_{RR}(R, D) > 0$. Further, $C^R_{RD}(R, D) > 0$.

(iii) $C^M(M)$ and $C^D(D)$ are both twice differentiable in their respective arguments. Also, $C^M(M)$ is increasing and convex in $M$, i.e. $C^M_M(M) > 0$, $C^M_{MM}(M) > 0$, and $C^D(D)$ is increasing and convex in $D$, i.e. $C^D_D(D) > 0$, $C^D_{DD}(D) > 0$.

While most of the assumptions are quite standard, two of these deserve some discussion. First, note that for ease of exposition we use the difference form contest success function, which is one of the two standard forms used in the literature. Later, in Section 5.2, we briefly examine the outcome under the alternative contest success function and argue that many of the results go through qualitatively. Second, consider the condition that the marginal cost of the rebel is increasing in development, i.e. $C^R_{RD} > 0$. This captures the idea that conflict stems from under-development. Thus, with greater development, the population would be less willing to support the rebel, thus increasing the marginal cost of the rebel. Further, in footnote 8 later on, we show that the equilibrium level of

[9] Later, we use $\zeta$ to derive comparative statics with regard to the rebel getting cost efficient or stronger.

[10] For our purpose, these cost functions are taken to be primitives. Following Azam (1995), one can however derive them endogenously starting from an initial endowment.

[11] In Section 5 later, we discuss the implications of considering alternative contest success functions. In the Appendix we demonstrate that assumption A1(i) holds for the difference form contest function.

development turns out to be zero in case $C^R_{RD}(R, D) < 0$, which is not the case of interest.

Both the government and the rebel are taken to be risk neutral. The utility function of the government is given by:

$$(1 - P(R, M))V - C^M(M) - C^D(D), \tag{1}$$

whereas the utility function of the rebel is given by:

$$P(R, M)V - \zeta C^R(R, D). \tag{2}$$

We examine a dynamic two stage game:

*Stage 1.* The government decides on the level of $D$, which is observed by the rebel.

*Stage 2.* The government and the rebel simultaneously decide on $M$ and $R$ respectively.

We solve for the sub-game perfect Nash equilibrium (henceforth SPNE) of this multi-stage sequential move game.

# 3 The Stage 2 Game

As usual, we start by solving the stage 2 game first. Thus for a given $D$, we simultaneously solve for the rebel's and the government's optimization problem.

Given the government's utility function (1), the government's reaction function is given by:

$$P_M(R, M)V = -C^M_M(M), \tag{3}$$

subject to the second-order sufficiency condition $-P_{MM}(R, M)V - C^M_{MM}(M) \leq 0$. Next, given the rebel's utility function (2), the rebel's reaction function solves the first order condition

$$P_R(R, M)V = \zeta C^R_R(R, D). \tag{4}$$

The second-order condition is given by $P_{RR}(R,M)V - \zeta C^R_{RR}(R,D) \leq 0$. Letting $(R^*(D), M^*(D))$ denote a Nash equilibrium of the second stage game, any such $(R^*(D), M^*(D))$ must satisfy (3) and (4).

We then examine the slope of the reaction curves of the rebel and the government. First consider the government's reaction function. From equation (3), we find that:

$$\frac{\partial M}{\partial R}|_{(3)} = -\frac{P_{RM}V}{P_{MM}V + C^M_{MM}}, \tag{5}$$

where ${}^{\partial M}/{}_{\partial R}|_{(3)} \leq 0$ if and only if $P_{RM} \geq 0$. For the government, if an increase in $M$ increases the marginal revenue for the rebel ($P_{RM} > 0$), then the government will respond to an increase in $R$ with an decrease in $M$.

Next consider the reaction function of the rebel. From equation (4), we find that

$$\frac{\partial R}{\partial M}|_{(4)} = -\frac{P_{RM}V}{P_{RR}V - \zeta C^R_{RR}}, \tag{6}$$

where ${}^{\partial R}/{}_{\partial M}|_{(4)} \leq 0$ if and only if $P_{RM} \leq 0$. This is intuitive. For the rebel, if an increase in $M$ decreases the marginal revenue for the rebel (i.e. $P_{RM} < 0$), then the rebel will respond to an increase in $M$ with an decrease in $R$.

Recall from assumption A1(i) that $P_{RM} > 0$ if and only if $R > M$. Thus, from (5) and (6), we have

**Lemma 1** *Let assumption A1 hold. Then the reaction function of the rebel (respectively the government) is negatively sloped whenever $R < M$ (respectively $R > M$).*

*Figure 1* plots the best response functions for the symmetric case where $V = 8$, $C^R = 0.5R^2$ and $C^M = 0.5M^2$ in the $R - M$ space. Here we have a symmetric equilibrium where $R^* = M^*$. However, asymmetric equilibrium is also possible, as shown in *Figure 2*. This considers the asymmetric case where $V = 8$, $C^R = R^2$ and $C^M = 0.5M^2$. Here we have an asymmetric equilibrium where $R^* < M^*$.

**Remark 1** *We can invoke Chowdhury and Kumar (2015b), who study the existence of pure-strategy Nash equilibrium in conflict games with difference form*

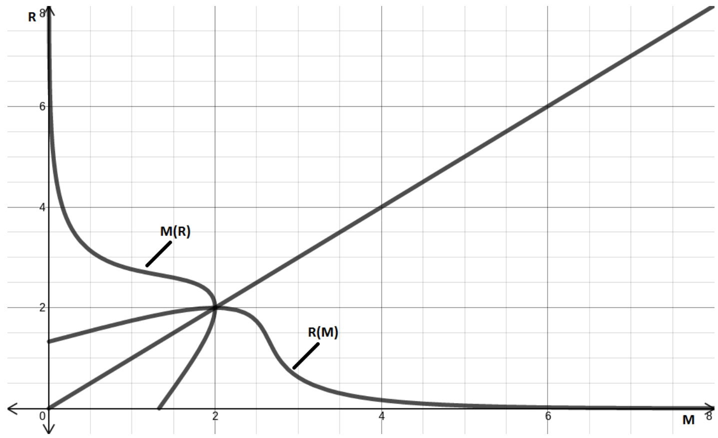



Figure 1: symmetric equilibrium

*contest success functions, to demonstrate that under some reasonable parameter restrictions, a unique and stable pure-strategy Nash equilibrium exists in the Stage 2 sub-game. In particular, the prize V should not be too valuable. For the quadratic cost functions* $C^R = 0.5R^2$ *and* $C^M = 0.5M^2$, *V should be less than* $6\sqrt{3}$. *For cost functions with both a linear and a convex component, we need the linear part of the cost function to have a relatively smaller weight for the existence of interior pure-strategy Nash equilibrium.*[12] *In the subsequent analysis we shall restrict attention to stable equilibrium in stage 2, and will write equilibrium to denote a SPNE that involves a stable equilibrium in stage 2.*

### 3.1 Effect of a Change in $D$

We next examine the effect of a change in $D$ on the Stage 2 outcome. Totally differentiating (3) and (4), and solving for ${dR^*(D)}/{dD}$ and ${dM^*(D)}/{dD}$ we have that:

$$\frac{dR^*(D)}{dD} = \frac{\zeta C^R_{RD}(P_{MM}V + C^M_{MM})}{(P_{RR}V - \zeta C^R_{RR})(P_{MM}V + C^M_{MM}) - (P_{RM}V)^2}, \quad (7)$$

$$\text{and } \frac{dM^*(D)}{dD} = -\frac{P_{RM}\zeta C^R_{RD}V}{(P_{RR}V - \zeta C^R_{RR})(P_{MM}V + C^M_{MM}) - (P_{RM}V)^2}. \quad (8)$$

[12] The proof is available on request.

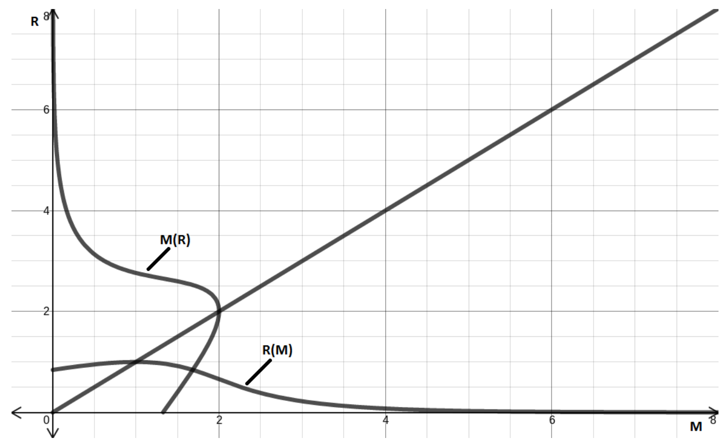



Figure 2: asymmetric equilibrium

First consider the sign of ${}^{dR^*(D)}/_{dD}$. Note that from the second-order sufficiency condition for the rebel's maximization problem, we have that $P_{RR}V - \zeta C^R_{RR} \leq 0$. Whereas from the second-order sufficiency condition for the government's maximization problem, we have that $-P_{MM}V - C^M_{MM} \leq 0$. These two together imply that the denominator is non-positive. Consequently, ${}^{dR^*}/_{dD}$ is opposite in sign to $C^R_{RD}$. Given that $C^R_{RD}$ is positive, i.e. an increase in the development activity increases the marginal cost of the rebel, an increase in the development activity decreases the equilibrium level of the rebellion activity.

We next consider the effect of a change in $D$ on $M^*(D)$, i.e. ${}^{dM^*}/_{dD}$. To that end we introduce

**Definition 1** *For any given $D$, consider a Nash Equilibrium $(R^*(D), M^*(D))$. In this Nash equilibrium the rebel is said to be 'dominant' if $R^*(D) > M^*(D)$, and the government is said to be 'dominant' if $M^*(D) > R^*(D)$.*

Note that ${}^{dM^*}/_{dD}$ has the same sign as $P_{RM}$. Recall that $P_{RM}$ is positive if and only if $R > M$, i.e. when the the rebel is 'dominant'. Thus in a situation where the rebel is dominant, i.e. $R^*(D) > M^*(D)$, the government increases $M$ with an increase in the development activity. Whereas if the government is the 'dominant' player, i.e. $M^*(D) > R^*(D)$, then, with an increase in $D$, the government decreases $M$.

We can summarize the preceding discussion in the following proposition.

**Proposition 1** *Let A1 hold.*

*(a) An increase in $D$ decreases $R^*(D)$.*

*(b) An increase in $D$ causes an increase in $M^*(D)$ if the rebel is dominant, i.e. $R^*(D) > M^*(D)$; whereas it leads to a decrease in $M^*(D)$ if the government is dominant, i.e. $M^*(D) > R^*(D)$.*

The first part of this result establishes the importance of $D$ as a strategic instrument, demonstrating that development has a negative effect on the equilibrium level of rebel activities. This result might explain why, in reality, one often finds that rebels want to block development works. The second part provides an interesting relationship between development and security-based measures. In particular, consider the case when the rebel is dominant. Suppose due to some exogenous reason, may be because of good monsoon or foreign aid, there is an increase in $D$. Then Proposition 3.1(b) shows that the government would find it optimal to *increase* the level of security-based measures. Intuitively, with the rebel being dominant, an exogenous increase in $D$ provides an opportunity to the government to strengthen it's position by increasing $M$.

The chain of effects play out as follows. An exogenous increase in development increases the marginal cost of rebellion activity. So this has a negative effect on $R$. Consider the region $R > M$ (see *Figure 1*). Over this region, $M$ is a strategic complement to $R$, and $R$ is strategic substitute to $M$. Hence starting with a negative effect on $R$, we have a positive effect on $M$. These effects work in opposite directions. Proposition 3.1 shows that in equilibrium, we have a decrease in $R$ and an increase in $M$. In region $R < M$, $M$ is strategic substitute to $R$, and $R$ is strategic complement to $M$. So, in this region, starting with a decrease in $R$, we have a decrease in $M$. Again, these effects work in opposite directions. Proposition 3.1 shows that in equilibrium, here we have an decrease in $R$ and $M$ both.

Next, we examine the effect of the rebel getting stronger, i.e. becoming more cost efficient, formalized as a decrease in $\zeta$. Using (3), we get, for a given $D$ and

$R$, $\partial M^*/\partial\zeta = 0$. Using (4), we get, for a given $D$ and $M$, $\partial R^*/\partial\zeta < 0$. So, with a decrease in $\zeta$, the government's reaction function remains unchanged whereas the rebel's reaction function shifts up. Next, totally differentiating (3) and (4), and solving for $dM^*/d\zeta$ and $dR^*/d\zeta$, we get (for a given $D$),

$$\frac{dM^*}{d\zeta} < 0 \; (\frac{dM^*}{d\zeta} > 0) \;\; \text{if} \;\; R < M \; (R > M), \tag{9}$$

$$\text{and} \;\; \frac{\mathrm{dR}^*}{\mathrm{d}\zeta} < 0. \tag{10}$$

The effects of a decrease in $\zeta$ on the equilibrium levels of $R$ and $M$, for a given $D$, is evident from *Figure 3* and *Figure 4* as well. Suppose $\zeta$ decreases, i.e. the rebel becomes stronger. The equilibrium level of rebel activity increases. The government plays an 'accommodative' role and decreases the level of security-based measures if the rebel is 'dominant' player to begin with. On the other hand, the government reacts aggressively and increases the level of security-based measures if the government is 'dominant' player to begin with.

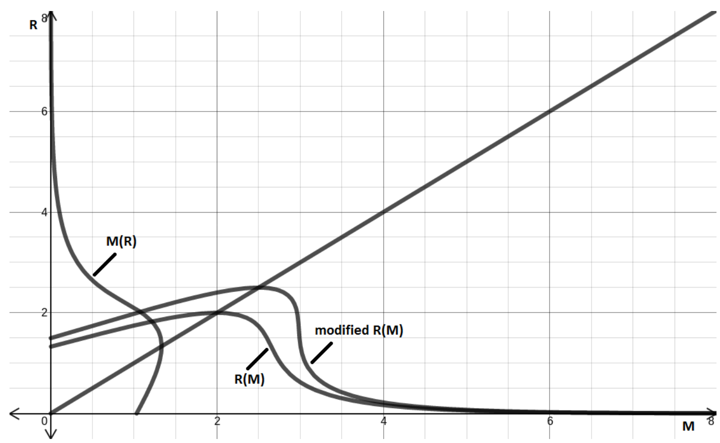



Figure 3: Comparative statics: rebel getting stronger

We can summarize this discussion in the following proposition:

**Proposition 2** *Let A1 hold. Suppose that the rebel becomes stronger, i.e.* $\zeta$ *decreases.*

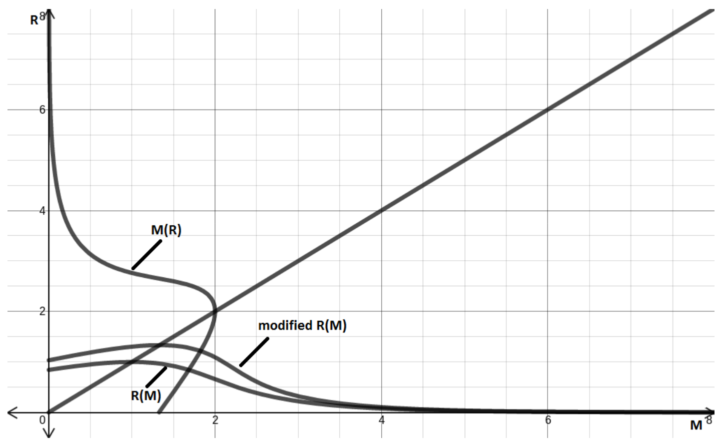



Figure 4: Comparative statics: rebel getting stronger

*(a) Then the rebel becomes more aggressive in the sense that, for a given $D$ and $M$, $R^*$ increases. Also, the equilibrium level of rebel activity increases.*

*(b) The equilibrium level of governmental security-based measures decreases if the rebel is dominant, i.e. $R^* > M^*$. Whereas if the government is dominant, i.e. $M^* > R^*$, then the governmental security-based measures increases.*

This result is similar to a result in Esteban and Ray (2011b), where they demonstrate that an "increase in activism by one contending group will create escalation or deterrence depending on whether that group was weaker or stronger to start with". They find that if a moderate group becomes more aggressive, it escalates the conflict with both groups increasing their military efforts; whereas if the stronger group becomes more aggressive, then the military efforts of both groups change in opposite directions.

# 4 The Equilibrium

We then solve for the SPNE of the two stage game. Denoting the government's utility, after incorporating the solution of the *Stage 2* game, by $U^G(D)$, one obtains

$$U^G(D) = [1 - P\left(R^*(D,\zeta), M^*(D,\zeta)\right)]V - C^M\left(M^*(D,\zeta)\right) - C^D(D).$$

Solving for the government's optimization problem in stage 1, the interior solution satisfies the following first-order-condition:

$$-P_R \frac{dR^*}{dD} V - C_D^D = 0. \tag{11}$$

Assuming that the corresponding second-order condition is satisfied, from (7) it follows that ${dR^*}/{dD}$ must be negative for equation (11) to be satisfied. This is true, given that $C_{RD}^R > 0$.[13]

Next, we explore the *comparative statics* impact if the rebel becomes stronger, i.e. $\zeta$ decreases. First, using (7), we find that[14]

$$\frac{\partial(\frac{dR^*(D)}{dD})}{\partial\zeta} = \frac{C_{RD}^R C_{MM}^M P_{RR} B V}{\{AB - (P_{RM}V)^2\}^2}, \tag{12}$$

where $A = P_{RR}V - \zeta C_{RR}^R \leq 0$ and $B = P_{MM}V + C_{MM}^M \geq 0$ (from the second-order sufficiency conditions). Note that $C_{RD}^R > 0$, $B \geq 0$, and, $C_{MM}^M > 0$. Hence this implies

$$\frac{\partial(\frac{dR^*}{dD})}{\partial\zeta} < 0 \quad \left(\frac{\partial(\frac{dR^*}{dD})}{\partial\zeta} > 0\right) \quad \text{if} \quad P_{RR} < 0 \quad (P_{RR} > 0)\,.$$

Recall that $P_{RR} < 0$ whenever $R > M$. Intuitively, with a decline in $\zeta$, the marginal cost of the rebellion activities decreases. Hence the rebel's optimization exercise demands that if $P_{RR} < 0$, then the rebel increases $R$. As a result ${dR^*}/{dD}$ increases. If the $P_{RR} > 0$, the rebel needs to decrease ${dR}/{dD}$ to maintain the optimality.

Next from (8), we have that

$$\frac{\partial(\frac{dM^*}{dD})}{\partial\zeta} = -\frac{P_{RM}VC_{RD}^R\{BP_{RR}V - (P_{RM}V)^2\}}{\{AB - (P_{RM}V)^2\}^2}. \tag{13}$$

[13]From (7), recall that ${dR^*}/{dD}$ is positive whenever $C_{RD}^R$ is negative. Thus the equilibrium level of development would be zero if, instead of assuming that $C_{RD}^R > 0$, we had taken that $C_{RD}^R < 0$.

[14]For difference-form contest success functions, we have $P_{RR} = P_{MM} = -P_{RM}$.

where $A = P_{RR}V - \zeta C^R_{RR} \leq 0$ and $B = P_{MM}V + C^M_{MM} \geq 0$ (from the second-order sufficiency conditions).

Interestingly, an increase in $\zeta$ increases ${dM^*}/{dD}$. As the rebel becomes weaker, the government uses $M$ more actively and it's responsiveness with regard to $D$ increases.

Summarizing the preceding discussion we have the following lemma.

**Lemma 2** *Let assumption A1 hold. Suppose that the rebel becomes stronger, i.e. $\zeta$ decreases.*

*(a) ${dR^*}/{dD}$ increases with a decrease in $\zeta$ if and only if the rebel is dominant, i.e. $R^* > M^*$, and decreases with a decrease in $\zeta$ if and only if the government is dominant, i.e. $R^* < M^*$.*

*(b) ${dM^*}/{dD}$ increases with a decrease in $\zeta$.*

Now, we use this lemma to explore the effect of a change in $\zeta$ on the equilibrium level of development.

Rewriting (11), we have:

$$U^G_D = -P_R\left(R^*(D,\zeta), M^*(D,\zeta)\right)\frac{dR^*}{dD}(D,\zeta)V - C^D_D = 0,$$

so that from the implicit function theorem, we obtain

$$\frac{dD^*}{d\zeta} = -\frac{\frac{\partial U^G_D}{\partial \zeta}}{\frac{\partial U^G_D}{\partial D}}. \tag{14}$$

Next, using the second-order sufficiency condition (for the maximization of the government's utility w.r.t $D$), we have ${\partial U^G_D}/{\partial D} < 0$. So, ${dD^*}/{d\zeta}$ has the same sign as that of ${\partial U^G_D}/{\partial \zeta}$.

We next turn to signing the expression ${\partial U^G_D}/{\partial \zeta}$, where

$$\frac{\partial U^G_D}{\partial \zeta} = -\left\{\frac{dR^*}{dD}V\left(P_{RR}\frac{dR^*}{d\zeta} + P_{RM}\frac{dM^*}{d\zeta}\right) + P_R V\frac{\frac{dR^*}{dD}}{\partial \zeta}\right\}. \tag{15}$$

In the above expression, we know that ${dR^*}/{dD} < 0$ (from (11)), $P_R > 0$, and ${\partial R^*}/{\partial \zeta} < 0$ (from (10)).

Consider the region $R > M$. Here we have $P_{RR} < 0$, $P_{RM} > 0$, and ${}^{dM^*}\!/_{d\zeta} > 0$ (from (9)). From *Lemma 2*, we also have ${}^{\partial dR^*/dD}\!/_{\partial\zeta} < 0$ in this region. Combining all these, we have ${}^{dD^*}\!/_{d\zeta} > 0$ in this region. So, if the rebels are dominant and they become stronger, the government decreases the level of development. We have seen similar accommodative policy by the government, when the rebels are dominant, in Proposition 3.2(b). Faced with a dominant opponent, the government takes an accommodative stance with regard to both of it's instruments, security based measures, as well as development.

In the region $R < M$, the result is however ambiguous. Here we have $P_{RR} > 0$, ${}^{dM^*}\!/_{d\zeta} < 0$, $P_{RM} < 0$, and ${}^{dM^*}\!/_{d\zeta} > 0$ (from (10) and (9)). We also have ${}^{\partial dR^*/dD}\!/_{\partial\zeta} > 0$ (from *Lemma 2*). So, in this region, we have ${}^{dD^*}\!/_{d\zeta} < 0$ if a change in $\zeta$ has a greater effect on $R^*$ relative to $M^*$, i.e. $|{}^{dR^*}\!/_{d\zeta}| > |{}^{dM^*}\!/_{\zeta}|$.

We can summarize this in the following proposition:

**Proposition 3** *Let assumption A1 hold. Suppose that the rebel becomes stronger, i.e. $\zeta$ decreases.*

*(a) In any equilibrium where the rebel is dominant, i.e. $R^* > M^*$, the government decreases the equilibrium level of development.*

*(b) In case the equilibrium involves the government being dominant, i.e. $M^* > R^*$, the result is ambiguous.*

This result has interesting implications. Suppose that the rebel has a cost advantage over the government in the sense that the rebel is dominant in the equilibrium, i.e. $R^*(D^*) > M^*(D^*)$. Now, if the rebel becomes stronger, i.e. $\zeta$ decreases, then the government's optimal response is to *decrease* its level of the development. When the government is dominant, the result is ambiguous. We find that there will be an increase in the equilibrium level of development if a change in $\zeta$ has a greater effect on the equilibrium level of rebel activity, relative to that on the equilibrium level of security based measures.

This result, particularly Proposition 4.1(a), provides a rationale for 'big push' in security based measures. If the government is not in a dominant position, small incremental increase in development does not help. To some extent, the strategic instrument of development has more power once the government is dominant.

# 5 Discussion and Extensions

We then discuss some robustness issues. In particular, we analyze the case where conflict can have an adverse impact on the prize itself. Further, we examine the implications of allowing for alternative contest success functions.

## 5.1 Generalized $V$

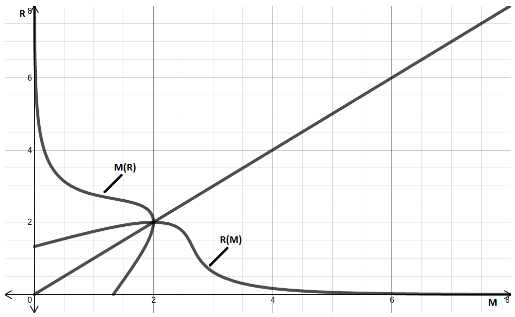
Note that under the current framework the only inefficiency from conflict stems from the two unproductive activities, $R$ and $M$, pursued by the two contestants. We then extend the analysis to allow for the fact that in reality conflict also inflicts other losses on the society, in terms of loss of human lives, weakening the fabric of the society, as well as decimating the productive capacity of the economy. To formalize this aspect we posit that the *effective* value of the prize, denote it by $\tilde{V}$, is decreasing in the level of conflict. One conceptual issue is to formalize the magnitude of conflict. Depending on the conflict technology, the effective level of conflict can be aptly described either by the aggregate level of conflict, i.e. $R + M$, and/or by the net level of conflict, say $(R - M)^2$. We thus consider the following effective prize function:

$$\tilde{V}(R, M) \equiv V - a(R + M) - c(R - M)^2,$$

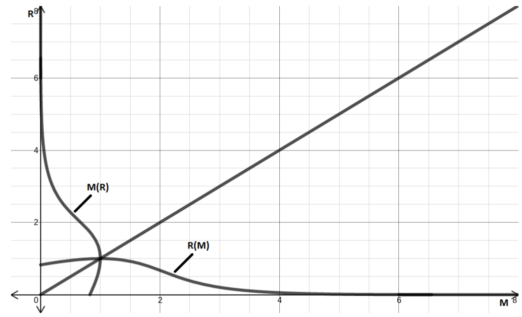
where, $a, c \geq 0$.

For ease of exposition consider an example where $V = 8$ and quadratic cost functions ($C^R = 0.5R^2, C^M = 0.5M^2$) for $R$ and $M$. Further, we consider two cases, one where $a = 1$ and $c = 0$, and another where $a = 0$ and $c = 1$ (see Figure 5).

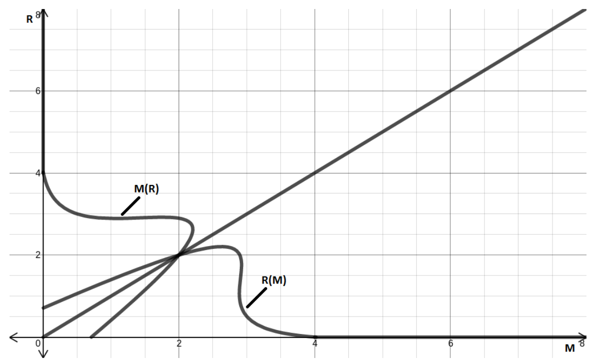
First, consider the case where $a = 1,\ c = 0$. Compared to our baseline model, we find that the level of fighting by both the government and the rebel goes down. This is intuitive since in this case the gains from fighting is lower. For the case




(a) constant value function: $a = 0, \quad c = 0$




(b) general value function: $a = 1, \quad c = 0$




(c) general value function: $a = 0, \quad c = 1$

Figure 5: general value function

where $a = 0,\ c = 1$, there are two qualitative differences. First, while the gains from winning is lower in this case also, the difference is not that pronounced because the loss depends on $R - M$, rather than on $R + M$. Second, starting from a situation where say, $R < M$, the rebel would have an additional incentive to increase $R$, as doing so increases the value of the prize itself. Qualitatively, the results in the two cases appear to be very similar.[15]

[15]Preliminary analysis suggests that these results are quite robust, and not dependent on the specific example considered here. The proofs are available on request.

### 5.2 Alternative specifications of the contest success function

An alternative contest success function, often used in the literature, is the ratio form, where the probability of success is given by $R/_{R+M}$.[16] For the standard ratio form it is well known that $P_{RR} < 0$, and $P_{MM} > 0$, but $P_{RM} > 0$ if and only if $R > M$. Given that the difference-form also satisfies the property that $P_{RM} > 0$ if and only if $R > M$, and that, for the difference-form, most of our central results actually follow from this property, many of our results go through under the ratio form also. In particular, *Proposition 3.1(a)* goes through. Strikingly, *Proposition 4* becomes stronger under the ratio form, in that in case the rebel becomes stronger, the level of development necessarily decreases irrespective of who is the dominant player.[17]

There are some changes though. Suppose the rebel become stronger, i.e. $\zeta$ decreases. Then $dR^*/_{dD}$ necessarily increases, whereas the effect on $dM^*/_{dD}$ depends on who is the dominant player, the rebel, or the government. Recall that both these results are different from that under the difference-form (see Lemma 2).

Jia et al. (2013) have also considered a specification of ratio form, which allows for draws, i.e. $P = R/_{s+R+M}$, $s > 0$. Here $P^s = s/_{s+R+M}$ is the probability of draw and $(1 - P - P^s)$ is the probability of winning for the government. For this specification as well, the signs of $P_{RR}$, $P_{MM}$, and $P_{RM}$ remain the same. Hence the preceding analysis for the standard ratio form applies in this case also. Similarly most of our results go through even if we adopt the other functional forms discussed in Jia et al. (2013), since, as discussed earlier, our results depend on the signs of $P_{RR}$, $P_{MM}$, and $P_{RM}$.[18]

[16] See Hirshleifer (1989) for a study of these alternative contest success functions. In a subsequent work, Jia et al. (2013) discusses different functional specifications of the ratio form (also referred to as the additive form) and (logistic as well as probit) difference form.

[17] The proofs are available on request.

[18] The general 'logit' specification mentioned in Jia et al. (2013), i.e. $P = 1/_{1+e^{k(M-R)}}$, where $k > 0$, is same as the general difference form that we have considered in the *Appendix* of this paper. For this general specification also, signs of $P_{RR}$, $P_{MM}$, and $P_{RM}$ are same as that of the contest success function ($k = 1$) used in this paper. They have also considered a 'probit' specification: $P = \Phi(M - R)$, where $\Phi$ is the cumulative distribution function of

Conceptually though, we feel that the difference form is more natural in this context. As pointed out by Hirshleifer (1989) also, the difference form has the property that both the rebel and the government has a positive probability of winning even if their respective conflict activities are zero. This seems to capture the notion that both the government, as well as the rebel has some measure of popular support, which cannot be totally over-turned by purely conflict activities.

### 5.3 Incorporating people's support

People's support, for either the government or the rebel, of course play an important role in such conflicts. Such conflicts are thus also a battle for the hearts and minds of the people, with contestants trying to mobilize such support in their favor. In this paper we have modelled this battle for hearts and minds in a reduced form, via the effect of $D$ on the rebel's marginal cost.

It would be of interest, to model this more explicitly though. In Chowdhury and Kumar (2015a), we have used an incomplete information framework to analyze this issue. There we have used a signalling game, where there is uncertainty over how benevolent the government really is, so that development works by the government can provide a credible signal in this respect. If the people are convinced that the government is benevolent, then they support the government. Alternatively, one can extend the analysis along the lines of Grossman (1991) where the population, depending on their opportunity costs, decide which cause to support. While this is beyond the scope of the present paper, as we want to focus on the strategic interactions between development and conflict, we plan to take up this issue in future work.

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the standard normal distribution. Upon derivation, we see that here also the signs of $P_{RR}$, $P_{MM}$, and $P_{RM}$ are same as that of the contest success function used in this chapter, e.g. $P_{RR} = P_{MM} = {}^{M-R}/\sqrt{2\pi} e^{-(R-M)^2/2}$ and $P_{RM} = -P_{RR}$.

# 6 Conclusion

Given the strong correlation between the lack of development and internal conflicts, one often finds opinion makers advocating development *instead* of tough measures so as to control internal conflicts. A survey in the Maoist affected region in India, suggests that the people also hold similar opinion (IMRB-TOI, 2010). While there can be no doubt that development has to play a critical role in this respect, we argue that the argument is much more nuanced.

First, we argue that while an *increase* in development decreases the level of rebellion activity, it *increases* the level of security based measures by the government. Thus strategically speaking development and tough measures are complementary, rather than substitutes.

Second, we find that if the rebel becomes stronger (i.e. becomes more cost efficient), then the government might find it optimal to *decrease* its level of development. This result has interesting implications regarding the negative correlation between development and conflict. While the popular wisdom has been that lower development *causes* conflict, our analysis suggests that a reverse causation, arising out of purely strategic considerations, may also be present.

We would however like to stress that this paper focuses on the purely strategic aspect of the trade-off between development and security-based measures. We ignore, for example, the fact that a benevolent government would value development for its own sake, and not just for purely strategic reasons. Among other possible extensions, it would be of interest to allow for multiple rebel groups. One agenda for future research would be to adapt the multi-rebel framework developed by Becsi and Lahiri (2007) and Lahiri and Vlad (2012) to analyze this trade-off.

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# 7 Appendix: Properties of Contest Success Functions

We establish some properties of the ratio-form and the difference form contest success functions. Recall that the ratio form involves $P(R,M) = {R^k}/{R^k+M^k}$, and the difference form involves $P(R,M) = {1}/{1+e^{k(M-R)}}$.

**The ratio-form probability function:**

$$\begin{aligned}
P(R,M) &= \frac{R^k}{R^k+M^k}, \\
\frac{\partial P(R,M)}{\partial R} &= \frac{kR^{k-1}M^k}{(R^k+M^k)^2}, \\
\frac{\partial P}{\partial M} &= -\frac{kR^kM^{k-1}}{(R^k+M^k)^2}, \\
\frac{\partial^2 P}{\partial R \partial M} &= \frac{kR^{k-1}M^{k-1}(R^k-M^k)}{(R^k+M^k)^3}, \\
\frac{\partial^2 P}{\partial R \partial R} &= \frac{kR^{k-2}M^k\{(k-1)M^k-(k+1)R^k\}}{(R^k+M^k)^3}, \\
\frac{\partial^2 P}{\partial M \partial M} &= \frac{kR^kM^{k-2}\{(k+1)M^k-(k-1)R^k\}}{(R^k+M^k)^3}.
\end{aligned}$$

Here, we have $P_R \geq 0$ and $P_M \leq 0$. $k=1$ is the most widely used version in the literature. For $k=1$, we have $P_{RR} < 0$ and $P_{MM} > 0$.

**The difference form probability function:**

$$\begin{aligned}
P(R,M) &= \frac{1}{1+e^{k(M-R)}}, \\
\frac{\partial P}{\partial R} &= \frac{ke^{k(M-R)}}{(1+e^{k(M-R)})^2}, \\
\frac{\partial P}{\partial M} &= -\frac{ke^{k(M-R)}}{(1+e^{k(M-R)})^2}, \\
\frac{\partial^2 P}{\partial R \partial M} &= \frac{k^2e^{k(M-R)}\{1-e^{k(M-R)}\}}{(1+e^{k(M-R)})^3}, \\
\frac{\partial^2 P}{\partial R \partial R} &= -\frac{k^2e^{k(M-R)}\{1-e^{k(M-R)}\}}{(1+e^{k(M-R)})^3}, \\
\frac{\partial^2 P}{\partial M \partial M} &= -\frac{k^2e^{k(M-R)}\{1-e^{k(M-R)}\}}{(1+e^{k(M-R)})^3}.
\end{aligned}$$

We have used the form with $k = 1$ in our paper here. We have $P_R > 0$ and $P_M < 0$. But now we have point of inflection at $R = M$, i.e., $P_{RR} = P_{MM} > 0$ if and only if $R < M$. Also, we have $P_{RR} = P_{MM} = -P_{RM}$. Further, we have $P(R = 0, M > 0) > 0$ for all $M$, and, $P(R > 0, M = 0) > 0$ for all $R$.

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