

Military Expenditure: Threats, Aid and Arms Races

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Abstract

Using global data for the period 1960-99 we estimate neighborhood arms races. We find that the level of military expenditure is strongly influenced by the expenditure of neighbors. We estimate an 'arms race multiplier', finding that an initial exogenous increase in military expenditure by one country is more than doubled in both the originating country and its neighbor. An implication is that military expenditure is, to an extent, a 'regional public bad'. Potentially, there is an offsetting public good effect if rebellions are deterred by military expenditure. However, instrumenting for military expenditure, we find no deterrence effect of military spending on the risk of internal conflict. Hence, there appears to be no regional public good effect offsetting the public bad arising from a neighborhood arms race.

1. Introduction

In this paper we investigate what determines military expenditure. We focus particularly upon whether such expenditure is a regional public 'bad', inflicting negative externalities across borders. The classic model in which military expenditure has this property is an arms race between neighbors: the purpose of the expenditure is to provide defense against the threat posed by the expenditure of the neighbor. The same level of defense can thus be achieved by the uncoordinated arms race equilibrium of mutually high expenditure, or by cooperative expenditure restraint. However, for many governments military expenditure has a further function of providing *internal* security. To the extent that rebellions have adverse neighborhood effects, if military expenditure deters rebellion it is a regional public *good*.

Previous studies of the determinants of military expenditure are reviewed by Hartley and Sandler (1990) and by Smith (1995). The main focus of the literature has been on developed country military expenditure during the Cold War, which was dominated by an arms race between NATO and the Warsaw Pact. This phenomenon generated both a theoretical and an empirical literature. The canonical theoretical model of the arms race is that of Richardson (1960), more recent work being surveyed in Brito and Intriligator (1995). The empirical literature naturally deployed the time series econometric approach. A smaller literature focuses on developing countries, which are our primary interest. Deger and Sen (1995) survey this literature which uses a cross-section approach (see for example, Maizels and Nissanke, 1986; Looney, 1989; Gyimah-Brempong, 1989). The dependent variable is the ratio of military spending to GDP, commonly referred to as the 'defense burden'. The explanatory variables include a range of political and economic factors, but, in contrast with the NATO-Warsaw Pact literature, arms races are not analyzed.

In this paper we provide what we believe to be the first integrated empirical analysis of developed and developing country behavior. Section 2 provides the foundations for the study by estimating a military expenditure function that incorporates both external threats and internal threats. The major impediment to such an analysis is a credible quantitative estimate of the internal threat. Indeed, since civil wars are now far more common than international wars, an omission of the internal threat would seriously impair any global analysis of military expenditure. For this step we rely upon our existing model of the risk of rebellion (Collier and Hoeffler, 2002a, 2002b). We find that military expenditure is influenced by both external and internal threats, with other influences being the enhanced political power of the military in non-democratic regimes, and the financial resources available to the government. In Section 3 we develop one important implication of the regression analysis, the existence of neighborhood arms races. This quantifies the 'regional public bad' nature of military expenditure. To the extent that military expenditure is driven by local arms races and by the political power of the military, a global reduction in spending would presumably be without serious social cost. However, to the extent that it is effective in deterring internal rebellion, military spending can have substantial benefits. Indeed, since rebellion in one country hurts the economies of neighboring countries, effective deterrence is a regional public good. In Section 4 we therefore investigate whether military expenditure is effective in deterring rebellion. Section 5 discusses the implications for international action towards the control of military spending.

2. What Motivates Military Expenditure?

On average countries spend around 3.4% of GDP on the military, but around this average there is enormous variation, ranging from 0.1% to 46%. In this Section we estimate a military expenditure function to explain this variation. The dependent variable is problematic because data on military expenditure are unreliable, as discussed by Brzoska (1995). Here we use data from the Stockholm International Peace Research Institute (SIPRI) for the period 1960-90, updated with data from the *Global Development Network*. We measure military spending as a proportion of GDP for 161 countries, averaged over each five-year period 1960-65...1995-99. Our regression analysis pools the data over countries and periods, yielding 563 observations for which we have complete data on the dependent and explanatory variables. As discussed below, an important advantage of this approach is that it enables us to introduce a measure of internal threat, constructed for precisely corresponding periods.

Military expenditure is motivated partly by the need for security, partly by the lobbying of interested parties, and partly by the financial resources available to the government. We include proxies for each of these in our regression.

The need for security

The most evident need for military expenditure is during periods of active warfare. We introduce dummy variables for participation in an international war, and for civil war. Unsurprisingly, both these variables are significant (Table 1, column 1).¹ International war raises expenditure by 2.5% of GDP, and civil war by 1.8% of GDP. We next introduce proxies for the risk of international warfare while at peace. We use three indicators of external threat during peacetime: the actual history of previous involvement in international conflict, the military expenditure of neighbors, and the population of the country. Previous participation in international conflict is likely to be interpreted politically as indicating a need for military expenditure whether or not it reflects an actual risk of invasion. We might also expect international war to remain within the political memory for a long period. We measure the previous history of participation by a dummy variable which takes the value of unity if the country has been involved in an external war prior to the period in question but subsequent to 1945. The dummy is positive for around 20% of our observations. It is highly significant, raising spending by around 1.3%. Presumably this risk fades with time, but we could not find any significant rate of decay over the observed period so possibly the process of decay is very slow. The military expenditure of neighbors proxies the capacity of neighboring countries to pose a threat. We measure it as the sum of the military expenditure of neighboring countries averaged over the five year period under consideration, divided by the sum of the five year average of GDP for the same countries.

¹ We also investigated variables measuring the months of international and civil war during the period. The dummy variables outperform these measures, implying that military expenditure does not usually jump in the month that war starts, nor sharply decline the month after it stops, but rather is also high shortly prior to, and shortly after wars.

Table 1: Determinants of Military Expenditure

	1	2
International War	2.513 (0.983)***	2.616 (1.217)**
Civil War	1.845 (0.614)***	2.186 (0.685)***
External Threat	1.269 (0.455)***	0.602 (0.821)
Neighbors' Military Expenditure	0.603 (0.109)***	0.728 (0.143)***
ln Population	-0.316 (0.108)***	-0.528 (0.155)***
Internal Threat	3.948 (2.337)*	6.666 (2.812)**
1995-99	-0.730 (0.320)**	-0.704 (0.519)
Democracy	-0.201 (0.042)***	-0.125 (0.058)**
ln GDP per capita	0.924 (0.230)***	1.109 (0.332)***
Israel	6.926 (2.211)***	5.583 (2.370)**
Aid/GDP _{t-1}		0.002 (0.031)
n	563	382
R ²	0.56	0.62

Note: Dependent variable is the defense burden. White standard errors in parentheses, ***, ** and * indicate significance at the one, five and ten percent level, respectively.

The inclusion of the military expenditure of neighbors allows us to investigate regional arms race effects.² Somewhat surprisingly in view of the focus of the developed country literature upon arms races, there are few studies in the empirical developing country literature that analyze the expenditure of neighbors as an explanatory variable. Dunne and Perlo-Freeman (2003) are a notable exception. Countries may be influenced by the expenditure of neighbors for reasons other than military threat. An alternative explanation is that, in the absence of clear indicators of military need, governments base their judgment on the behavior of their neighbors: emulation might account for what appears to be rivalry. For whatever reason, the behavior of neighbors is important, being the most significant variable in the regression and we return to it in the next section. Countries with larger populations are potentially more secure from external threat and so have less need of military expenditure. We take the natural logarithm of population. The variable is significant with the expected sign.

² Since we regress a country's defense burden on its neighbors' weighted defense burden we avoid to a certain extent the simultaneity issues arising from neighborhood effects. For a detailed discussion see Manski (1993).

We now turn to the analogous risk of internal rebellion. The incidence of civil war is now around ten times greater than that of international war, and so the risk of rebellion is potentially considerably more important as an influence on military expenditure than is the fear of international war. To our knowledge this has not previously been investigated. For the dominant developed country literature on military expenditure it was clearly irrelevant, while for developing countries, where internal security was potentially important, there was no empirical model of the threat. We use our recent model to estimate this threat (Collier and Hoeffler, 2002a, 2002b). The model estimates the underlying risk for each five-year period during 1960-99 for 126 countries in terms of some observable characteristics prior to the conflict period. The model is based on tests of a wide range of economic, social, political, geographic and historical characteristics. Economic factors are found to be particularly important: the risk of civil war is higher if the level of per capita income is low, if the growth rate in the previous period is low, and if the country is dependent upon primary commodity exports. Social composition is also important: 'ethnic dominance', with the largest ethnic group constituting a majority of the population but with a significant minority presence, doubles the risk. Geography and history also matter: a dispersed population and a recent history of war increase the risk. The modeled risk of civil war does not take into account events such as political protests or assassinations, although they may well both cause conflict and be early indicators of an escalating sequence of events. However, robustness tests indicate that no important persistent characteristics of countries have been omitted as explanatory variables. Hence, the remaining risk is due to transient factors such as political events and personalities.

The predicted risk of conflict is not only correlated with the occurrence of conflict but with its scale. Potentially, the predicted risk of conflict may therefore be correlated with the level of military expenditure not because governments raise military spending prior to conflict in response to objective levels of risk, but simply because spending is higher in larger conflicts. To control for this, we multiply the predicted conflict risk by a dummy variable that takes the value of zero during those five-year periods in which the country is engaged in civil war. Hence, all variation in the predicted risk of conflict is confined to periods of peace. Globally, the model explains only around a third of conflict risk. Nevertheless, the predicted risk of conflict is significant in the regression and its effect is substantial. Moving from zero risk to 100% risk would increase military spending by almost four percent of GDP. Evidently, governments raise military expenditure in anticipation of civil conflict.

The final variable proxying security need is a dummy variable for the period post-1994. This is significant and negative, with spending reduced by 0.7% of GDP. This is presumably picking up the coordinated reduction in military spending following the end of the Cold War. Dummy variables for all previous periods, including that for 1990-94 are insignificant. While the end of the Cold War obviously pre-dates 1995, there were evidently substantial lags in implementing the implications for the appropriate level of military spending.

The lobbying of interested parties

In addition to security needs, military expenditure may be influenced by lobbying. The most evident beneficiary of military expenditure is the military itself. A high level of expenditure enables a larger size of the military, implying better prospects of

promotion, higher salaries, and larger bureaucratic empires. While the interest of the military in military expenditure is probably broadly similar across societies, the ability of the military to influence budgetary decisions differs considerably. We might expect that the greater the political power of the military interest, the higher would be military expenditure. The actual expenditures incurred as a result of such influence may have little or no relation to military capability. For example, during a long period of military government in Nigeria the navy gradually accumulated more admirals than it had ships. This high expenditure on admirals is more plausibly explained by the position of senior naval officers in the government than by the distinctive operational needs of the Nigerian navy. Indeed, it was indeed promptly rectified upon the resumption of civilian rule. We proxy differences in the ability of the military interest to secure patronage-motivated expenditures by the extent to which the government is democratic. We postulate that the less democratic is the government the more reliant it is upon the military and so the higher will be patronage expenditures for a given level of risk. We use the Polity III measure³ of the degree of democracy, which rates the general openness of political institutions on a scale of 0 (low) to 10 (high). The variable is highly significant and the coefficient is substantial: a dictatorial society will spend two percent of GDP more on the military, controlling for other characteristics, than a fully democratic society.

The financial resources of government

Finally, we turn to proxies for the ability to pay. There is no reason to expect military spending to rise proportionately with per capita income. Superficially, security might be expected to be a necessity, so that it would rise less than proportionately with income. In fact, security appears to be a luxury. The share of GDP devoted to military spending is strongly increasing in the level of per capita income. This is less surprising than it might first appear. Military spending is a component of government expenditure, and total government expenditure as a share of GDP is strongly increasing in income. The explanation for this may simply be that the capacity for the state to tax and to borrow increases with development.

Countries may be able to spend beyond the level implied by their income because they receive money from foreign governments. Usually, such aid is intended for the purposes of development, and then the issue is whether donors are able to enforce their intentions on recipient governments. However, in rare cases finance is explicitly earmarked for military purposes. Globally, the most notable instance of explicit finance for military expenditure is the support provided by the USA for Israel. We would therefore expect to find that the level of Israeli military expenditure has exceeded that implied by its level of security threat and its income. To test for this we introduce a dummy variable for Israel. It is highly significant and very large: Israeli military expenditure is almost seven percent of GDP larger than implied by its other characteristics (including the military expenditure of its neighbours).

For some governments development aid is an important financial resource and it is particularly interesting to determine the extent to which this inadvertently augments military spending. Other evidence suggests that earmarked aid can be highly fungible within a budget. For example, Fezioglu et al (1998) find that with the exception of

³ See Jagers and Gurr (1995) for a full description.

transport (where projects tend to be very large), the sector to which aid is ostensibly tied does not influence the sectoral composition of government expenditure. However, precisely because donors understand this possibility and are particularly sensitive to the accusation of inadvertently funding military expenditure, they exert a generalized collective influence opposing military expenditure. That is, their defense against fungibility of aid into military expenditure goes beyond their normal attempts to protect the level of expenditure for which the aid is earmarked, to a concerted attempt to contain expenditure on the specific item of concern. Potentially, donors could fail to achieve their earmarked expenditures and yet be successful in curtailing military expenditure: governments could increase expenditures in less sensitive areas. We test for this by including aid as a percentage of GDP, averaged over the five-year period, as an explanatory variable. As reported in column 2, aid is completely insignificant. Donors appear to be fully successful in preventing aid from leaking into military expenditure.

The model of column 1 is parsimonious, yet it provides quite a reasonable level of explanatory power with more than half the variance explained. We experimented with variants without disturbing these core results. For example, if the dependent variable is measured as a log, most t-statistics are considerably higher, with the predicted risk of civil war becoming significant at 5%, but the overall fit of the model is slightly worse. We now turn to one particular implication of the model, the existence of regional arms races.

3. Neighborhood Arms Races

Our core regression finds that in determining the level of military spending, governments respond to the level set by their neighbors. The motivation underlying this interdependent behavior may be benign, as in emulation, or aggressive. Distinguishing between these motivations is important if the concern is the prospect of international war. However, here our concern is simply the level of spending: regardless of motivation, such behavior generates neighborhood arms races.

The analytics of a neighborhood arms race are straightforward. Each country's defense burden, m_i , is determined by an exogenous component, a_i , plus an endogenous response to the expenditure of its neighbors:

$$m_i = a_i + b_i \cdot \sum_{j=1}^n m_j \quad \text{where } i \neq j \text{ and } n = 1, \dots, N \quad (1)$$

We first consider a simple two country case. Assume that an island is divided into two countries, so that each country only has the other as a neighbor. The analysis is depicted graphically in Figure 1 showing the military expenditure response functions for two countries, A and B. The initial equilibrium is at E_1 . If this is disturbed by a unilateral decision of country A to increase its military expenditure, the new equilibrium will be E_2 in which because country B has responded to the initial increase, country A finds it must increase its budget more than it had intended.

If the neighbors have a common exogenous component of military expenditure, a , it is straightforward to calculate the effect of a common exogenous increase in military

spending. In equilibrium the countries have the same defense burden and we can solve for m_i :

$$m_i = \frac{a}{(1-b)}. \quad (2)$$

Differentiating (2) with respect to a shows the extent to which a common exogenous increase in military spending escalates as a result of interdependence. We term this the *arms race multiplier* (ARM):

$$ARM = \frac{1}{(1-b)}. \quad (3)$$

Although we have illustrated the arms race multiplier through a two country model, it applies wherever neighboring countries face a common exogenous shock to their military spending, regardless of the number of countries involved. Using the results from the first regression in Table 1 the ARM is 2.52. That the ARM is much greater than unity suggests that where common exogenous influences are important, there is a major difference between the uncoordinated (arms race) level of military expenditure and the level that would be chosen through coordination.

There are several circumstances in which neighboring countries indeed face a common exogenous increase in their military spending. We now consider a particularly important one, namely, if neighbors have a war with each other. Recall that our core regression finds that once a country has participated in an international war it exogenously chooses a considerably higher level of military spending. In terms of Figure 1, if the initial equilibrium is disturbed by a war between the two neighbors, both A and B are subject to a common shock which increases their exogenous expenditures. These exogenous increases then trigger responses that raise the new equilibrium levels of spending to E_3 . From Table 1, the coefficient on the dummy for previous participation in international warfare implies an exogenous increase in military spending of 1.2 percentage points. This exogenous increase is augmented by the arms race multiplier, so that the equilibrium increase is three percentage points of GDP. In turn, this has implications for the cost of warfare: in the absence of negotiated reductions in post-conflict military spending, *much of the true cost of an international war might accrue after it is over*. As an illustration, the brief war between Ethiopia and Eritrea in 2000 has currently left a legacy of military spending far above international norms in both countries: 7% of GDP in Ethiopia and 24% in the less populated Eritrea. If these high levels of spending persist, their present value could easily exceed the costs incurred during the war. Although both countries have other neighbors, for military purposes each country may regard the other as the only pertinent neighbor for determining the appropriate level of military spending, so that chosen spending is highly interdependent.

The ARM applies only if both the country and its neighbors experience a common exogenous increase in military expenditure. If only one country exogenously increases its expenditure, then there are two arms race multipliers, that for the country with the initial increase (the 'arms race multiplier for own expenditure' : ARMOE), and that

for the neighbors (ARMNE). Now the multipliers depend critically upon the number of pertinent neighbors. Where there is only a single neighbor, the multipliers are:

$$ARMOE = \frac{1}{(1-b^2)} \quad \text{and} \quad ARMNE = \frac{b}{(1-b^2)}.$$

Applying the regression coefficient, $ARMOE = 1.57$, and $ARMNE = 0.95$.

For purposes of illustration, imagine that Chile and Argentina were to consider each other as the only pertinent neighbor for military purposes. Suppose, hypothetically, that the government of Chile decided to purchase military aircraft at a cost of \$100m in excess of the original military budget. Given these suppositions, if responses were to conform to the global behavioral norm, the eventual cost to Chile of its decision would be \$157m and that to Argentina \$95m. Consider the implications of $ARMOE$ and $ARMNE$ for Chilean decision takers. If they were to take the naïve view that their decision would not alter the decision of Argentina, then their cost-benefit analysis of whether to increase military spending would weigh the gains of achieving a \$100m military advantage over Argentina, versus the opportunity costs in terms of foregone alternative expenditures. This naïve view would considerably mis-state the true cost-benefit calculation. The true budgetary cost to Chile would eventually be \$157m, and the military advantage over Argentina would be only \$62m. More generally, the 'benefit' of incremental exogenous expenditure is:

$$\frac{\partial(m_A - m_B)}{\partial a} = 0.62, \quad (4)$$

while its cost is the $ARMOE$, so that the naïve calculation would exaggerate benefits relative to costs by 2.52, that is by the same factor as the ARM .

As the number of pertinent neighbors increases the $ARMOE$ and the $ARMNE$ decline. Generalizing to the n -country case:

$$ARMOE = \frac{1}{\left(1 - \left(\frac{b}{n-1}\right)^2\right)} \quad (5)$$

and

$$ARMNE = \frac{\frac{b}{n-1}}{\left(1 - \left(\frac{b}{n-1}\right)^2\right)}. \quad (6)$$

Thus, as the number of neighbors increases, the arms race multipliers converge to the following values: $ARMOE \rightarrow 1$ as $n-1 \rightarrow \infty$ and $ARMNE \rightarrow 0$ as $n-1 \rightarrow \infty$. This convergence is quite rapid as shown in Figures 2 and 3.

So far we have considered two types of exogenous adverse shocks: an international war and a unilateral increase in military spending by one country. We now consider a favorable shock, democratization. From Table 1, if a country's political system switches from dictatorship to full democracy, its military expenditure will fall by around two percent of GDP. For the country which democratizes this is then augmented by the ARMOE. To continue with our Chile-Argentina hypothetical example, the democratization of Chile in the 1990s would eventually have reduced its military expenditure by around 3.1 percent of GDP. Further, due to the ARMNE, Argentina would have reduced its spending by 1.9 percent of GDP. Thus, there is not only a national 'democracy dividend' due to a fall in military expenditure, but through the ARMNE democracy has a regional public good effect enabling neighbors to reduce their expenditures. Governments thus have a direct economic interest that their neighbors should be democratic.

Finally, we consider the effect of an increase in the risk of civil war of ten percentage points across a neighborhood. Such an increased neighborhood risk might arise because of the greater availability of armaments. For example, during the social breakdown in Albania the huge government stores of military equipment were ransacked, and this made rebellion easier over the entire Balkan area. Such an increase in risk would directly raise military spending in each country by around 0.4 percent of GDP. This would in turn be increased through the ARM to one percent of GDP. Hence, through its effect on the military spending of neighbors, the risk of civil war is a regional public bad. Similarly, civil war in one country is itself a regional public bad, directly raising military expenditure in that country by around 1.8 percent of GDP. Through the ARMOE this is increased to 2.9 percent, and through the ARMNE, the expenditure of neighboring countries is raised by 1.7 percent.

4. How Effective is Military Expenditure in Deterring Rebellion?

In Section 3 we quantified the effects of regional military expenditure as a regional public 'bad'. However, potentially, military expenditure is also a regional public good. As noted above, via the ARMNE, civil war is a regional public bad. This is consistent with Murdoch and Sandler (2002) who find that civil war in one country reduces the growth rate across an entire neighborhood. In Section 2 we found that governments respond to the objective risk of civil war by increasing their military expenditure. If this expenditure is effective in reducing the risk of civil war then there is an offsetting positive externality. The net neighborhood externality of military spending would therefore be *a priori* ambiguous.

Our model of the risk of rebellion enables us to investigate the efficacy of military spending as a deterrent. Clearly, since military spending rises in correct anticipation of rebellion, unless this effect is controlled for, spending will spuriously appear to increase the risk of rebellion. To allow for this we therefore instrument for military expenditure. Fortunately, as established in Section 2, there are some powerful influences on military expenditure which are unrelated to the risk of rebellion, notably external threats. Since countries differ enormously in the extent of external threats they differ considerably in the level of military expenditure. We therefore predict military expenditure using the preferred regression of Table 1, excluding the coefficient on internal risk. The resulting instrumented military expenditure is entered as an explanatory variable in our model of rebellion. The results are shown in Table 2.

Table 2: Deterrence Effects of Military Expenditure on Rebellion

	1	2	3
Ln GDP per capita	-1.068 (0.287)***	-1.053 (0.285)***	-1.265 (0.326)***
(GDP growth) _{t-1}	-0.074 (0.046) p=0.11	-0.0812 (0.048)*	-0.054 (0.051)
Primary commodity exports/GDP	16.988 (5.553)***	17.083 (5.532)***	20.053 (6.787)***
(Primary commodity exports/GDP) ²	-23.763 (10.462)**	-24.060 (10.367)**	-31.026 (13.825)**
Social fractionalization	-0.0003 (0.0001)***	-0.0003 (0.0001)***	-0.0003 (0.0001)***
Ethnic dominance (45-90%)	0.540 (0.358)	0.534 (0.358)	0.581 (0.399)
Peace duration	-0.004 (0.001)***	-0.004 (0.001)***	-0.004 (0.001)***
ln Population	0.377 (0.142)***	0.366 (0.144)***	0.540 (0.181)***
Geographic concentration	-0.889 (0.975)	-0.964 (0.998)	-1.545 (1.097)
Predicted Military expenditure _{t-1}	0.065 (0.063)	0.256 (0.171)	
Predicted Military expenditure _{t-1} ²		-0.016 (0.014)	
'Efficient' Military expenditure			0.081 (0.074)
'Inefficient' military Expenditure			-0.054 (0.064)
N	611	611	495
No of wars	43	43	34
Pseudo R ²	0.22	0.22	0.26
Log likelihood	-122.11	-121.31	-97.99

Notes: Dependent variable is a bivariate indicator of an occurrence of civil war in any given sub-period 1965-69, ..., 1995-99. All regression include a constant. Standard errors in parentheses. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

Predicted military expenditure is completely insignificant in explaining rebellion (column 1). This is quite a striking result since there is a wide variation in predicted military expenditure. We would therefore expect that were military expenditure to have a substantial deterrence effect it would be observable in this regression. We also experimented with non-linear effects (column 2), predicted military expenditure and its square are neither individually nor jointly significant. We investigate further by attempting to disaggregate military expenditure into two components: 'more effective' and 'less effective' in terms of military power. The idea is to distinguish between spending which purchases military power, and that which simply reflects waste. Were we able to make such a distinction empirically, we would expect only 'effective' military expenditure even potentially to have a deterrence effect. In practice, our empirical proxies are sufficiently crude that the most that can be hoped is that the military expenditures that they measure are differentially effective. We define the

more effective component as that which is a response to some genuine reflection of the external threat and the ability to finance deterrence. We proxy this by the military expenditure of neighbors, by whether there has been a previous international war, by the size of population, and by per capita GDP, so that effective military expenditure is the sum of the military expenditure predicted by the coefficients on these variables in Table 1. We define the less effective component as that induced by the lack of democratization, which is more likely to reflect patronage. In the event, neither of these components is close to significance (column 3).

Thus, although governments increase military spending in an effort to deter rebellion, the expenditure appears to be ineffective. Evidently, once a war has developed, military spending can influence its outcome, but during the inception stage of rebellion a large military response might be ineffective, or even counterproductive: excessive repression by government forces assists rebel recruitment and appears to be a common error of counter-insurgency. Indirectly, military spending might even inadvertently increase the risk of conflict through its adverse effect on economic growth. Knight, et al. (1996) find that military expenditure significantly reduces growth, while we find that growth reduces the risk of rebellion (Collier and Hoeffler, 2002a, 2002b).

5. Conclusion: Some Implications for Policy

We have found that the level of military expenditure chosen by a government is strongly influenced by the levels chosen by neighboring governments. This creates multiplier effects for the other influences on military spending, notably war and the threat of war. Since the incidence of civil war is around ten times higher than international war, it is the former that is the more important influence on military spending. We found that while military spending responds to the objective risk of civil war, it is not effective in reducing that risk: military spending does not deter rebellion.

The conjunction of an arms race effect with the absence of a deterrence effect suggests that military expenditure is a regional public 'bad'. Even if *international* deterrence is effective, approximately the same level of external security can presumably be achieved over a wide range of military expenditure as long as an entire neighborhood changes its level of spending in common. Since military spending is a regional public bad it will be over-supplied by national-level decisions.

During peacetime, the decisions of one country on military expenditure powerfully affect those of its neighbors. Because spending is so closely matched by neighbors, an increase in military spending by one country has little effect upon its external security. Further, it has no discernable effect upon deterring internal insecurity. This provides two reasons for thinking that military spending is usually excessive. Governments may well not be fully aware of the ineffectiveness of military expenditure in enhancing both external and internal security. As noted above, if they fail to recognize the arms race multiplier effects, they substantially exaggerate the contribution of an increase in the military budget to external security. Similarly, many governments might imagine that in strengthening the military they are deterring rebellion. Further, even if governments are fully aware of the arms race effects, unless their military

expenditure is coordinated with their neighbors it will still be excessive. The regional negative externalities of unilateral decisions need to be internalized through regional coordination.

Since the spillovers are regional rather than global, and since coordination usually becomes more difficult as the number of players increase, the most important forum is likely to be the region. Regions have indeed invested enormous effort in some aspects of policy coordination. However, this has been predominantly focused upon lowering regional barriers to trade. Regional trade agreements have become so popular that globally there are now more agreements than there are countries (World Bank, 2000). However, regional cooperation on reciprocal reduction of trade restrictions probably offers far less scope for mutual benefits than cooperation on reciprocal reduction in military spending. Preferential tariff reductions create powerful redistribution effects within the region, so that some countries, and almost certainly some sectors within a country, may lose absolutely. By contrast, reciprocal reductions in military spending can readily be designed to be mutually beneficial while leaving security unaffected.

Despite this scope for regional coordination of military spending, such agreements are rare. An important obstacle to reaching an agreement is the low observability of military expenditure. If such expenditures are only observable with a long lag, the first government to breach the agreement can gain a temporary military advantage and so launch a successful war. During the Cold War these problems were resolved by expensive technologies of observation. Most governments of developing countries lack such technology. In this situation the IFIs may have a facilitating role both as neutral but privileged observers and as external enforcers of regional agreements (see Murshed and Sen (1995) for a discussion of the scope for IFI peace conditionality). The IFIs have much better access to information on military spending than is available to hostile neighboring governments. They can potentially impose aid reductions in response to breaches of regional agreements that would sharply raise the cost of increasing military budgets. Such a practice would not require the IFIs to take sides in political disputes. Rather, any actions would be responses which were already authorized by regional agreements which the IFIs had been invited to underwrite.

The donor community has a further interest in the reduction of military expenditure in aid-recipient countries. Military expenditure in the context of poverty is rightly seen as wasteful. Hence, donors quite reasonably attempt to reduce the level of military expenditure by aid recipients. Our analysis has suggested a further justification for such efforts, namely as a coordinating device that a region can itself use for reciprocal reductions in expenditure. In the absence of a natural regional leader willing to incur the costs of such leadership, a donor norm can supply a credible common target.

Figure 1: Military Expenditure Reaction Functions

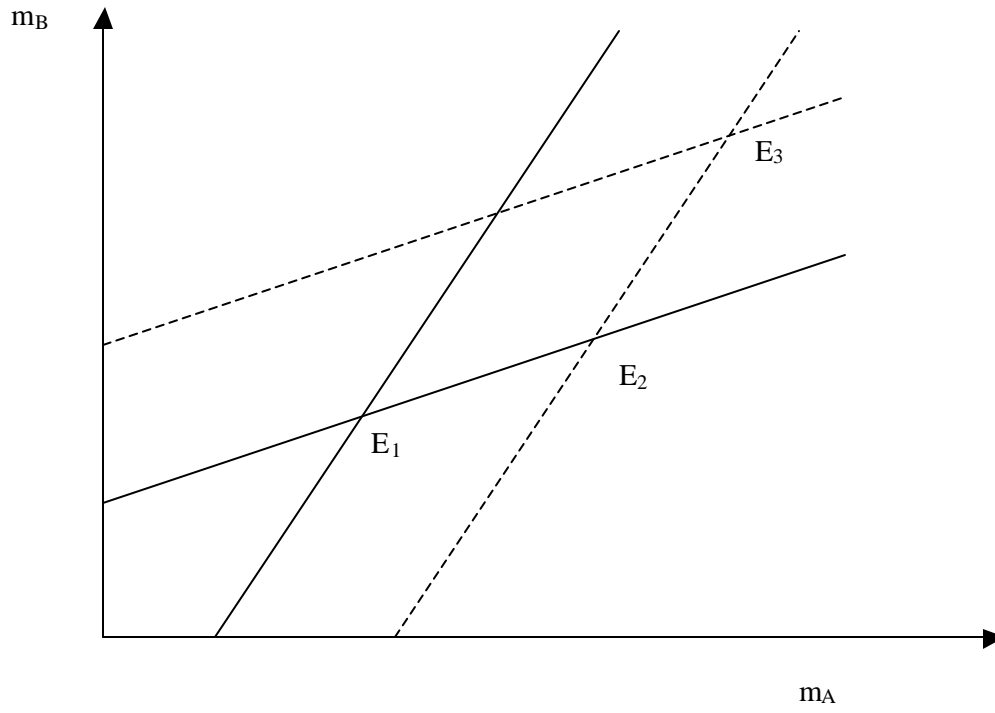


Figure 2: Arms Race Multiplier (ARMOE)

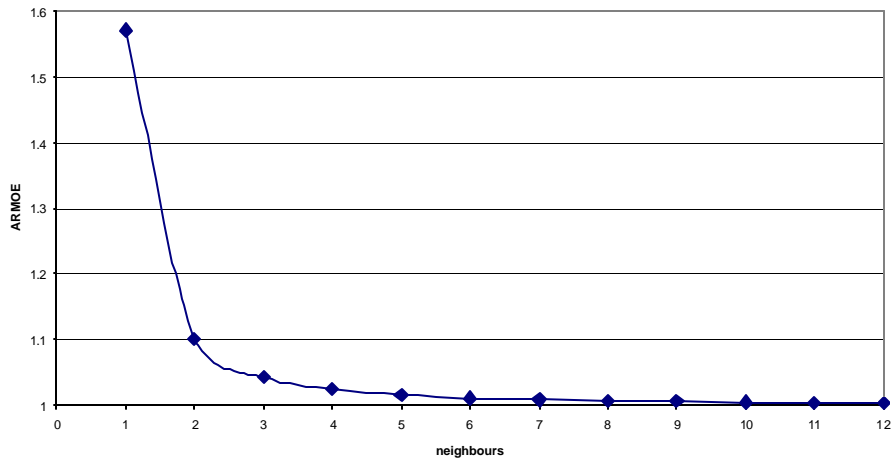
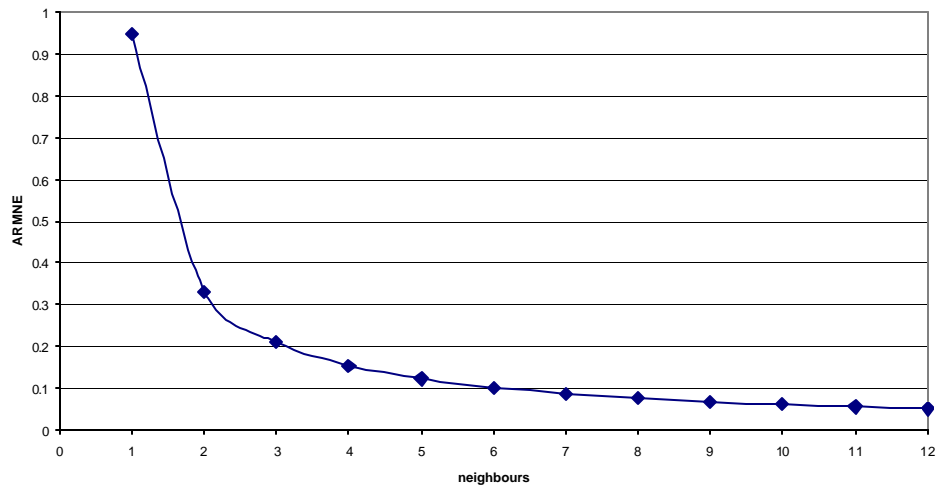


Figure 3: Arms Race Multiplier (ARMNE)



Appendix

Table A1: Descriptive Statistics

	<i>mean</i>	<i>st. dev.</i>	<i>min.</i>	<i>max.</i>	<i>N</i>
Military Expenditure	3.355	4.275	0.1	45.96	563
International War	0.073	0.260	0	1	563
Civil War	0.078	0.269	0	1	563
External Threat	0.226	0.418	0	1	563
Neighbors' Military Expenditure	3.578	3.488	0	22.211	563
ln Population	15.984	1.42	12.716	20.773	563
Internal Threat	0.053	0.075	0	0.608	563
Democracy	4.195	4.370	0	10	563
ln GDP per capita	7.853	1.050	5.403	9.852	563
Aid/GDP _{t-1}	4.608	6.278	-0.047	55.240	382

Data

The model presented in Table 2 primarily uses data from Collier and Hoeffler (2002a) and the data can be obtained from Anke Hoeffler's website:

<http://users.ox.ac.uk/~ball0144>.

Aid/GDP

We measure aid as the percentage of official overseas development assistance and official aid in GDP. Aid and GDP are measured in current US dollars and we use the average percentage over the preceding five years in our analysis. Data source: World Development Indicators 1999.

Civil War

Is a dummy variable which takes a value of one if the country experienced a civil war during the period. A civil war is defined as an internal conflict in which at least 1,000 battle related deaths (civilian and military) occurred per year. We use mainly the data collected by Singer and Small (1984, 1994) and according to their definitions Nicholas Sambanis updated their data set for 1992-99.

Democracy

Measures the general openness of the political institutions, it ranges from zero (low) to ten (high). The data source is the Polity III data set as discussed by Jagers and Gurr (1995).

Ethnic dominance (45-90%)

Using the ethno-linguistic data from the original data source (Atlas Narodov Mira, 1964) we calculated an indicator of ethnic dominance. This variable takes the value of one if one single ethno-linguistic group makes up 45 to 90 percent of the total population and zero otherwise.

External Threat

Is a dummy variable which takes a value of one once a country was involved in an international war. Here we consider all international wars after WWII. The main data source is Singer and Small (1984, 1994). We updated this data set by using Gle ditsch *et al* (2002), this resulted in the addition of two international wars (Ethiopia – Eritrea, 1998-ongoing as of the end of 1999) and India and Pakistan (1999-ongoing as of the end of 1999).

(GDP growth)_{t-1}

Using the above income per capita measure we calculated the average annual growth rate as a proxy of economic opportunities. This variable is measured in the previous five year period.

Geographic Concentration

We constructed a dispersion index of the population on a country by country basis. Based on population data for 400km² cells we generated a Gini coefficient of population dispersion for each country. A value of 0 indicates that the population is evenly distributed across the country and a value of 1 indicates that the total

population is concentrated in one area. Data is available for 1990 and 1995. For years prior to 1990 we used the 1990 data.

Internal Threat

Is the predicted probability of a civil war breaking out. This prediction is based on the core model as presented in Collier and Hoeffler (2002a).

International War

Is a dummy variable which takes a value of one if the country experienced an international war during the period. The main data source is Singer and Small (1984, 1994). We updated this data set by using Gleditsch *et al* (2002), this resulted in the addition of two international wars (Ethiopia – Eritrea, 1998-ongoing as of the end of 1999) and India and Pakistan (1999-ongoing as of the end of 1999).

ln GDP per capita

We measure income as real PPP adjusted GDP per capita. The primary data set is the Penn World Tables 5.6 (Summers and Heston 1991). Since the data is only available from 1960-92 we used the growth rates of real PPP adjusted GDP per capita data from the World Bank's World Development Indicators 1998 in order to obtain income data for 1995. Income data is measured at the beginning of each sub-period, 1965, 1970, ..., 1995.

ln Population

Population measures the total population, the data source is the World Bank's World Development Indicators 1998. Again, we measure population at the beginning of each sub-period.

Israel

Is a dummy variable which takes the value of one for Israel and zero for all other countries.

Military Expenditure

Military expenditure is measured as a proportion of GDP, also commonly referred to as the defense burden. Data for 1960-90 was obtained from the Stockholm International Peace Research Institute (SIPRI) and we used data from the Global Development Network for 1991-1999.

<http://www.worldbank.org/research/growth/GDNdata.htm>

Neighbors' Military Expenditure

For country i we calculated the weighted average of the neighbors' defense burden by dividing the sum of the neighbors' total military expenditure, M_i , by the sum of the neighbors' total national income, Y_i :

$$m_i = \frac{\sum_{j=1}^N M_j}{\sum_{j=1}^N Y_j} \quad \text{where } i \neq j \text{ and } n = 1, \dots, N$$

For our analysis we excluded countries for which we had no military expenditure data. We are grateful to James Murdoch and Todd Sandler who made their data set on neighbors available to us (Murdoch and Sandler, 2002). Income data was obtained from the Penn World Table (see data source for **ln GDP per capita**). We multiplied the RGDPCH series by the total population to calculate total income.

Peace Duration

This variable measures the length of the peace period since the end of the previous civil war. For countries which never experienced a civil war we measure the peace period since the end of World War II until 1962 (172 months) and add 60 peace months in each consecutive five year period.

Primary commodity exports/GDP

The ratio of primary commodity exports to GDP proxies the abundance of natural resources. The data on primary commodity exports as well as GDP was obtained from the World Bank. Export and GDP data are measured in current US dollars. The data is measured at the beginning of each sub-period, 1965, 1970, ..., 1995.

Social fractionalization

We proxy social fractionalization in a combined measure of ethnic and religious fractionalization. Ethnic fractionalization is measured by the ethno-linguistic fractionalization index. It measures the probability that two randomly drawn individuals from a given country do not speak the same language. Data is only available for 1960. In the economics literature this measure was first used by Mauro (1995). Using data from Barro (1997) and Barrett (1982) on religious affiliations we constructed an analogous religious fractionalization index. Following Barro (1997) we aggregated the various religious affiliations into nine categories: Catholic, Protestant, Muslim, Jew, Hindu, Buddhist, Eastern Religions (other than Buddhist), Indigenous Religions and no religious affiliation. Data is available for 1970 and 1980 and the values are very similar. For 1960, 1965 and 1970 we used the 1970 data and for 1980, 1985, 1990 and 1995 we use the 1980 data. For 1975 we use the average of the 1970 and 1980 data.

The fractionalization indices range from zero to 100. A value of zero indicates that the society is completely homogenous whereas a value of 100 would characterize a completely heterogeneous society. We calculated our social fractionalization index as the product of the ethno-linguistic fractionalization and the religious fractionalization index plus the ethno-linguistic or the religious fractionalization index, whichever is the greater. By adding either index we avoid classifying a country as homogenous (a value of zero) if the country is ethnically homogenous but religiously diverse, or vice versa.

War starts

The dependent variable in Table 2, 'war starts', takes a value of one if a civil war started during the period and zero if the country is at peace. If a war started in period t and continues in $t+1$ we record the value of the war started value as missing. A civil war is defined as an internal conflict in which at least 1000 battle related deaths (civilian and military) occurred per year. We use mainly the data collected by Singer and Small (1984, 1994) and according to their definitions Nicholas Sambanis updated their data set for 1992-99.

1995-99

Is a dummy variable which takes a value of one for the time period 1995-99 and zero for all other periods.

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