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Unintended Consequences: Does Aid Promote Arms Races?*

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Abstract

Using global data for the period 1960–99, we model military expenditure. Neighbours' military spending and development aid are important determinants of military expenditure. An implication of the model is that there are regional arms races which are fuelled by aid. Potentially, aid is encouraging a 'regional public bad'. There may, however, be an offsetting public good effect if military spending deters rebellions. In a simultaneous equation model, we find no deterrence effect of spending on the risk of civil war. Hence, there appears to be no regional public good effect offsetting the public bad arising from a neighbourhood arms race.

I. Introduction

Military expenditure in developing countries constitutes a substantial claim on government budgets. The opportunity cost in terms of foregone social and growth-promoting expenditures is evident. As donors provide substantial finance to budgets, either directly or as a result of fungibility, there is also a widespread fear that aid intended for poverty reduction may in fact be financing the military. Governments nevertheless choose to spend substantial resources on the military. The most reasonable motivation is the need for security. Historically for most countries the main security threat was external – the country may need to fight an international war. However, international wars are now very rare. For developing countries, the main security threat is likely to be internal. For example, during 2002 there were 21 large-scale violent conflicts of which only one was international (Stockholm

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International Peace Research Institute, SIPRI, 2003). As the social and economic consequences of internal conflict are often appalling, governments may reasonably conclude that money spent on reducing the risk of internal conflict is well spent despite its high direct opportunity costs for social and economic development.[1]

In this paper, we investigate both the revealed motivation for military spending in developing countries and its effectiveness in deterring internal conflict. We find that the risk of internal conflict is indeed one important motivation for military spending, but that other less reasonable pressures are also present – for example, the political power of the military lobby affects the defence budget. Further, we find that military spending is at best ineffective in reducing the risk of internal conflict. Governments do not, in fact, face the hard choice between internal security and social expenditures that they imagine.

While from the perspective of internal security, military spending appears to be merely unproductive, once external security considerations are introduced such spending becomes positively harmful. We find that there are neighbourhood arms race effects, which turn military spending into a regional public 'bad', inflicting negative externalities across borders.

Finally, budgets in most developing countries are partially financed by aid, either directly through budget support, or indirectly because of the fungibility of projects. There is a widespread concern that inadvertently aid is financing military spending. We investigate whether aid indeed leaks into military budgets.

Section II provides the foundations for the study by estimating a military expenditure function that attempts a comprehensive coverage of motivations, incorporating both external and internal threats. In section III, we develop one important implication of the regression analysis, the existence of neighbourhood arms races. This quantifies the 'regional public bad' nature of military expenditure. To the extent that military expenditure is driven by local arms races, a neighbourhood 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, as rebellion in one country hurts the economies of neighbouring countries, effective deterrence of internal rebellion may be a regional public good. In section IV, we therefore investigate whether military expenditure is effective in deterring rebellion. Section V discusses the implications for international action towards the control of military spending.

II. Modelling military expenditure

Previous studies of the determinants of military expenditure are reviewed by Hartley and Sandler (1990, 2001, Vol. 1, Chap. 2) and Smith (1995). The main focus of the literature has been on military expenditure by developed countries 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.

[1]On the social and economic consequences of internal conflict see Collier *et al.* (2003).

The canonical theoretical model of the arms race is that of Richardson (1960), more recent work being surveyed in Smith and Dunne (forthcoming). Following Smith (1989) and Skaperdas (1996), we hypothesize that military expenditure, M, is an input to security, S. That is, it reduces the bargaining power of those external and internal enemies who are willing to resort to violence. Conventional military contest success functions posit that in the event of a conflict the chances of success, P, depend upon the balance of forces, typically:

$$P = P(M_g/(M_g + M_e)) \tag{1}$$

where g stands for government forces and e enemy forces.

Such a functional form implies that an increase in the size of enemy forces raises the marginal productivity of government forces, $(\mathrm{d}(\mathrm{d}P/\mathrm{d}M_g)/\mathrm{d}M_e > 0)$, and so provides the underpinnings for an arms race.[2]

Spending can be adjusted in response to changes in need. Spending will thus be higher during wartime than during peace. However, because spending can only be adjusted slowly, the credibility of a military deterrent depends upon the level of spending during peacetime. By reducing the chances of enemy victory in the event of military conflict, peacetime military spending deters military challenges by enemies – thus producing security. In addition to the current level of the forces of potential enemies, other external factors, E, also influence the need for security. Together with the contest function, this implies a security function of the form:

$$S = S(M_g, M_e, E). \tag{2}$$

Security enters the welfare function along with non-military expenditures, C. Welfare is given by:

$$W = W(S, C, I) \tag{3}$$

where I are exogenous internal political influences which parameterize shifts in the objective function. The welfare function is maximized subject to a budget constraint:

$$Y \geq P_m M_g + P_c C \tag{4}$$

where P_m, P_c are prices.

Maximization of equation (3) subject to equations (2) and (4) then implies a demand function for military spending:

$$M_g = M_g(Y, P_m, P_c, M_e, E, I). \tag{5}$$

The empirical literature has also been dominated by attempts to estimate the arms race during the Cold War (Smith, Dunne and Nikolaidou, 2000). It naturally deployed the time-series econometric approach. A smaller literature focuses on developing countries, which are our primary interest. Deger and Somnath (1991)

[2]Contest success functions can take various forms. The ratio of forces, used here, is probably the most common, but alternative specifications can sometimes have significantly different implications. See Konrad and Skaperdas (1998).

survey this literature which uses a cross-sectional 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 'defence 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 analysed.

As our focus is on developing countries, and upon how military spending changes during development, we use a pooled cross-sectional approach, with a global coverage of countries during the period 1960–99, divided into eight sub-periods. Although this approach has been conventional in much of the growth literature, it has only just begun to be applied to the phenomenon of military spending (Dunne and Perlo-Freeman, 2003). Specifically, we have data for 161 countries, averaged over each 5-year period 1960–64, . . . , 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.

We now attempt to estimate a regression that approximates as closely as possible to the theoretical model specified in equation (5). The dependent variable in equation (5), military expenditure, is specified in absolute terms. However, because absolute levels of military spending are highly correlated with the level of development, it is more revealing to define the dependent variable as the share of military spending in GDP. The dependent variable is nevertheless problematic because data on military expenditure are unreliable, as discussed by Brzoska (1995). Here we use data from the SIPRI for the period 1960–90, updated with data from the *Global Development Indicators*. So measured, 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%.[3]

Our core regression is presented in Table 1, column 1. Our dependent variable is the logarithm of the defence burden (military spending as a share of GDP). Our explanatory variables attempt to proxy those included in equation (5). We are able to develop satisfactory proxies for Y, M_e, E and I, but not for the relative price of military services. Generating a satisfactory relative price series would be a major undertaking.[4] Evidently, as the dependent variable is expenditure rather than the quantity of purchases, the sign of the price response is *a priori* ambiguous, depending upon whether the quantity response is greater than or less than minus unity. In effect, our analysis assumes the special case in which price effects wash out

[3]SIPRI has recently updated its publicly available information on military spending. To determine whether this updating materially affected our results we checked the correlation between the data set used in the present analysis and the newly updated figures. The two data sets were correlated at 0.98, suggesting that none of our results would be significantly altered.

[4]For example, actual payments to military personnel are clearly in part endogenous. Changes in the price of military equipment are highly dependent upon its composition: prices of small arms tended to decline, whereas prices for advanced technology probably tended to rise.

TABLE 1

Determinants of military expenditure

	1	*2*	*3*	*4*
International war	0.448 (0.127)***	0.476 (0.133)***	0.560 (0.161)***	0.577 (0.154)***
Civil war	0.297 (0.124)**	0.305 (0.125)***	0.294 (0.142)**	0.215 (0.145) $P = 0.145$
External threat	0.520 (0.078)***	0.595 (0.090)***	0.503 (0.108)***	0.468 (0.108)***
(Neighbours' military expenditure)$_{t-1}$	0.098 (0.012)***	0.098 (0.012)***	0.126 (0.018)***	0.114 (0.019)***
ln population	−0.042 (0.024)*	−0.042 (0.024)*	−0.119 (0.033)***	−0.077 (0.040)*
Internal threat	0.735 (0.450)*	1.004 (0.533)*	1.041 (0.552)*	1.191 (0.498)**
1995–99	−0.358 (0.108)***	−0.358 (0.010)***	−0.232 (0.146)	−0.273 (0.148)**
Democracy	−0.059 (0.010)***	−0.058 (0.010)***	−0.061 (0.013)***	−0.066 (0.013)***
ln GDP per capita	0.237 (0.043)***	0.234 (0.045)***	0.232 (0.068)***	0.388 (0.108)***
Israel	1.332 (0.276)***	1.265 (0.279)***	1.279 (0.310)***	1.213 (0.312)***
Internal threat */external threat		−1.168 (0.750) $P = 0.12$		
Aid/GDP			0.005 (0.007)	0.033 (0.017)**
N	482	482	339	339
R^2	0.44	0.44	0.47	0.45

Notes: Dependent variable is the logarithm of the defence burden. All regressions include a constant. Robust standard errors in parentheses; values are significant at ***1%, **5% and *10% levels. Results for column 4 were obtained by using two stage least squares (2SLS) estimation, first-stage regression results are reported in Table A3. Allowing for heteroscedasticity in the error terms, we use a Hansen test as an overidentification test of the instruments and obtain a test-statistic of $\chi^2_3 = 3.28$ ($P = 0.35$).

because the coefficient is not significantly different from zero. As our focus is on neighbourhood arms races rather than time trends the omission is unlikely to be important. We discuss our proxies for the other explanatory variables in turn.

The need for security

As discussed above, one part of the demand for military forces is the need to maintain external and internal 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, both proxying *E*, external factors influencing the level of the threat from enemies. Unsurprisingly, both these variables are significant.[5] International war raises expenditure by 1.5% of GDP, and civil war by about 1% of GDP.

We next introduce proxies for the risk, while at peace, of participation in international warfare. One potential indicator of the current risk of such participation is the history of participation. Past involvement in a war may indicate either a hostile relationship with a neighbour, or an international security role. For example, the participation of Australia in the Korean War set a precedent for its subsequent involvement in East Asian conflicts, notably the Vietnam War, which in turn set a precedent for its current involvement in East Timor and the Solomon Islands. Hence, participation in a war may change both the perceived level of threat, and the obligation to participate in international security provision. 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, this being a further proxy for *E*. The dummy is positive for around 20% of our observations. It is highly significant, raising spending by around 1.8%. 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.[6]

A second historical variable of evident significance for military expenditure is the ending of the Cold War. This defused both the arms race between NATO and the Warsaw Pact, and several of the proxy wars in developing countries. Again, this proxies the concept *E*. There is no unambiguous precise dating for the end of the Cold War – the failure of the communist coup d'état in August 1991 is sometimes seen in retrospect as the decisive end of the period of confrontation. However, during the early years of Yeltsin the reversion to hard line Soviet leadership could not be discounted. As our data is organized into 5-year sub-periods, our effective options are that the end of the Cold War should have had significant effects on military spending in either the entire period January 1990 to December 1999, or only during the shorter period January 1995 to

[5]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.

[6]Specifically, we introduced a variable on the duration of the period since the last international conflict, but this was insignificant.

December 1999. This is again an empirical matter. We find that if the end of the Cold War is defined on the entire decade of the 1990s there is no significant effect, whereas if it is defined on the shorter period since 1995 it significantly reduced military spending by 1.3% of GDP. One possible reason for this apparent delay in the effect of the ending of the Cold War is that around 1991 global military spending temporarily surged because of the war in Kuwait. However, it is also possible that the combination of initial uncertainty as to the evolution of events in the former Soviet Union, and bureaucratic inertia in budget reductions, should produce a relatively long lag between the headline political events such as the dismantling of the Berlin wall, and actual military spending.

We now introduce the current military capacity of potential enemies, M_e, in equation (5). For developing countries, currently, most potential external threats are from neighbours and in the present analysis, we use the military spending of neighbours as a proxy for the potential threat. While this is evidently only an approximation to the countries that actually constitute threats, it has the advantage of being entirely exogenous. A more politically informed identification of threatening countries may be endogenous to chosen spending levels: for example, a country with a large military capability is likely to adopt a more aggressive foreign policy. Thus specified, the demand for security is related to the military spending levels of neighbours – the classic situation posited in neighbourhood arms races. Countries may be influenced by the expenditure of neighbours for reasons other than military threat. In the absence of clear indicators of military need, governments may base their judgment on the behaviour of their neighbours: emulation might account for what appears to be rivalry.

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 analyse the expenditure of neighbours as an explanatory variable. Dunne and Perlo-Freeman (2003) are a notable exception. There are various ways in which the military spending of neighbours can be specified. To distinguish between threat and emulation effects we create two distinct measures. If the military spending of neighbours poses a threat then presumably what matters is the absolute level of such spending, rather than the proportion of GDP which the neighbour devotes to such spending. Thus, if a small country (say Eritrea) is concerned about the threat posed by a larger neighbour (Ethiopia), it will aspire, if possible, to match the absolute level of its neighbour's forces, not the share of GDP devoted to the military. As our dependent variable is the share of GDP that the country devotes to military spending, we can express this aspiration as being the absolute level of the neighbour's military spending *as a share of home country GDP*. If, by contrast, international threats are seen as negligible, the choices of a neighbour may still be influential in the internal budget struggle between the Ministries of Finance and Defence because of emulation, but in this case the relevant influence will be the military spending of the neighbour relative to its own GDP.

Most countries have multiple neighbours. We therefore measure both the neighbourhood threat and emulation variables as aggregates. The threat variable is

the sum of neighbours' military spending, divided by home country GDP, and the emulation variable is the sum of neighbours' military spending divided by the sum of neighbours' GDP. Thus, for example, although India has borders with both Nepal and China, the level of threat that it faces is dominated by the military spending of China.

Empirically, the behaviour of neighbours is important. To reduce the econometric problem of interdependence, we introduce neighbour's military spending with a lag.[7] When both the threat and emulation variables are entered into the regression, the former is completely insignificant whereas the latter is significant. The emulation variable remains significant when the threat variable is eliminated. This suggests that genuine international threats are largely captured by the history of past international conflict, already included in the regression, whereas other neighbourhood influences are predominantly peer-group effects.

We now turn to the analogous risk of internal rebellion which is a further proxy for *E*. The incidence of civil war is around 10 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 is clearly irrelevant as the risk of civil war is negligible in these societies. For developing countries, where internal security is potentially important, there has been no empirical model of the threat. Recently, however, several models have been developed to estimate such risks. We use our own model, which we have already applied in other contexts (Collier and Hoeffler, 2002a,b, 2004a). The key features of the model are that risks are related to the level, growth and structure of income. Social, historical and geographic characteristics are also included: for example, ethnic and religious diversity. Other models of the risk of internal conflict use similar explanatory variables, although differing in detail (Fearon and Laitin, 2003; Hegre *et al.*, 2001). Our modelled risk of civil war does not take into account high-frequency 'triggering' events such as political protests or assassinations. Although these might be good indicators of imminent conflict, we are not attempting to model the short-term escalation of military spending in the run-up to civil war. Rather, we are trying to explain the average level of military spending over a 5-year period in terms of slower changing risk factors that prevailed prior to the period. Our model estimates the risk of civil war that prevails on average during each 5-year period.

We introduce this predicted risk of civil war into the regression. As it is a generated regressor we correct standard errors accordingly.[8] The risk is significant in the

[7]As we regress a country's defence burden on the lagged neighbours' weighted defence burden, we avoid the simultaneity issues arising from neighbourhood effects. For a detailed discussion, see Manski (1993) and Anselin, Florax and Rey (2004).

[8]We would like to thank Brian Poi (Stata Corp.) for help with the programming. We follow the method developed by Murphy and Topel (1985).

regression and its effect is fairly substantial. The typical low-income country at peace has a risk of internal conflict of 13.8% in any 5-year period (Collier and Hoeffler, 2004b). A doubling of this risk would raise military expenditure by 10%. The variable is potentially endogenous: higher levels of military spending might reduce the risk of civil war. In section IV we investigate this further. However, such endogeneity would tend to produce a *negative* association between spending and risk whereas we find a positive one.

Although both external and internal risks increase military spending, it is unlikely that the two effects are additive. Just as the same alarm may protect against two distinct risks of fire, so the same army may protect against two distinct risks of war. At one extreme, the two risks could be entirely uncorrelated, be sufficiently low that they are highly unlikely to occur together, and be capable of being met by the same military provision. Thus, having made provision for the higher of the two risks, the lower risk would not increase the need for military spending. This is the case of full complementarity. Such complementarity would be reduced were the two risks are highly covariant. Generally this is not the case: civil wars are concentrated in the poorest countries whereas participation in international wars is not. However, sometimes a hostile neighbour might encourage an internal insurgency: for example, the government of India perceives this to have been a tactic of past Pakistani governments in Kashmir. Conversely, the existence of an internal insurgency occasionally tempts neighbours into opportunistic attacks, as when Somalia invaded Ethiopia during its prolonged civil war. Complementarity would also be reduced if the type of military spending required to meet an external threat differed substantially from that needed to meet an internal threat: for example, jet fighters vs. helicopters. Hence, the complementarity of military provision against the two risks cannot be assumed *a priori*, but is an empirical matter. We investigate it by including an interaction term between our measure of internal risk and our measure of external risk. If complementarity is substantial this should be significantly negative, as the separate effects of each component of risk would exaggerate actual military needs. The interaction term with our proxy for external threat, previous international war, is negative and significant at about 12% (Table 1, column 2). According to the coefficients, a country with both a past history of international war and a 50% risk of civil war spends no more on the military than were either one of these risks set to zero (although it spends a lot more than were *both* risks set to zero). There is thus some basis for thinking that military provisions for internal and external threats are complements. Consistent with our interpretation of the influence of neighbours' military spending being because of emulation rather than threat, the interaction between our measure of internal threat and our measure of neighbours' military spending is insignificant.

As our dependent variable is military spending relative to GDP, it is neutral with respect to the size of the society. Yet potentially, the production of security may be subject to scale economies or diseconomies. We investigate such potential scale effects by including the logarithm of the population of the country. The variable is

indeed negative – larger countries have less need for military spending relative to their GDP.[9]

The lobbying of interested parties

In addition to security needs, military expenditure may be influenced by domestic political interests, as hypothesized in equation (5) through the variable *I*. 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 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 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 measure[10] 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 2% of GDP more on the military, controlling for other characteristics, than a fully democratic society. In an attempt to control for endogeneity, we instrumented democracy with its lagged value. The results were unaffected.

The financial resources of government

Finally, we turn to proxies for the ability to pay, which is the variable *Y* in equation (5). 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 as 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

[9]We also investigated other specifications of population, notably population relative to that of the largest neighbour. However, we found no specification that outperformed the simple inclusion of the above population variable.

[10]See Jaggers and Gurr (1995) for a full description.

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, by far 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 8% of GDP larger than implied by its other characteristics (including the military expenditure of its neighbours).

More usually, foreign financial assistance is targeted to development rather than security. Such aid is earmarked, usually through being tied to projects. However, evidence suggests that earmarked aid can be highly fungible within a budget. For example, Feyzioglu, Swaroop and Zhu (1998) find that with the exception of 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. There is thus a real possibility that development finance inadvertently ends up funding increased military spending. However, precisely because donors understand this possibility and are particularly sensitive to it, they try to depress military expenditure.[11] The agency problem in inhibiting fungibility of aid *into* military expenditure is much easier than that of inhibiting fungibility of aid *out of* development projects. If military spending increases coincident with an increase in aid but with tax revenue constant, then donors will reasonably interpret this as evidence of abuse. By contrast, as long as the development project is completed, the counterfactual that it would have been undertaken even without aid is unobservable. Thus, 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 5-year period, as an explanatory variable. As reported in column 3, aid is insignificant. At first sight, donors thus appear to be successful in preventing aid from leaking into military expenditure. However, an alternative interpretation of this result is that donors maintain the integrity of their aid budgets in aggregate by reducing aid *ex ante* to countries that adopt high levels of military spending. That is, aid may be endogenous to the government's chosen level of military spending.

To allow for this possibility we instrument aid. In our methodology, we broadly follow Tavares (2003). He argues that the aid outflows from the individual donor

[11]For example, such was British pressure on the government of Uganda that in 2001 when the President wished to increase the military budget beyond planned levels he first wrote to the British Minister of International Development. He received a strong rebuttal.

countries are good instruments: when a donor country changes its total outflow, which is usually for domestic budgetary reasons, recipient countries that are culturally and geographically closer to that donor country experience an exogenous change in aid inflows. Hence, much of the variation in a country's aid receipts is exogenous to its own actions.

Our sample consists of 85 aid recipient countries and we used the Organisation for Economic Co-operation and Development (OECD) aid outflows to construct instrumental variables. We concentrate on bilateral outflows from the five largest donors: Japan, the USA, France, Germany and the UK. In 1999, about 52% of global aid was provided by these five donors. The data source for the aid outflows is the OECD (2001) database. We then generate four variables to capture the political, geographic and cultural distance of each donor from each recipient. For political distance we use an index of UN voting affinity (Gartzke and Jo, 2002). The values for the affinity data range from −1 (least similar interests) to 1 (most similar). We proxy geographic proximity by the inverse of the distance in kilometres between capitals of the recipient and donor countries. Cultural distance is captured by dummy variables for a common language and for a common principal religion. All our distance indicators are invariant over time but vary across countries, while the aid outflow variables are invariant across recipient countries but vary over time. The aid inflows vary both across recipient countries and over time. We regress the aid inflows on all the exogenous variables and the product of the aid outflows times the four distance indicators. For our five donor countries we can potentially use 20 instruments. However, no recipient country shares a common language with Japan. We then follow the instrumental variable (IV) approach, reducing the set of 20 IVs stepwise. The resulting first stage results are reported in Table A1. Using a Hausman test we reject ordinary least square (OLS) in favour of IV estimation, i.e. aid is endogenous and should be instrumented in our model.[12]

The coefficient on instrumented aid is significant and positive. Thus, corrected for endogeneity, aid does appear to be fungible into military spending. During the Cold War some aid was provided on the basis of political allegiance. We would expect this to be much more pronounced on the part of the superpowers. Soviet aid is already excluded from our data, but the US aid was at times substantial. We therefore repeat the analysis of the effect of aid on military spending, excluding the US aid. The results were in fact marginally more significant. Hence, the result that aid has financed military spending cannot be attributed to such intentional funding on the part of the US government.

The coefficient shows that on average a 1 percentage point increase in aid as a share of GDP would increase military spending by 3.3%. As military spending, in our sample, averaged 3.355 percentage points of GDP, this implies that on average around 11.4% of development aid leaks into military budgets. While this is quite a modest level of leakage, it would imply that for large aid recipients a substantial part

[12]We obtained a *t*-statistic of 1.67.

of their military budgets are inadvertently financed by aid. For example, on average, African countries receive a net aid inflow of 11.1 percentage points of their GDP and spend 3.17 percentage points of GDP on the military. Hence, to the extent that they conform to the global pattern of aid leakage, around 40% of African military spending is inadvertently financed by aid. However, the absence of a significant relationship when aid is not instrumented suggests that, anticipating such a leakage, donors divert funds *ex ante* from those governments with particularly large military budgets.

The models of Table 1 are parsimonious, yet they provide quite a reasonable level of explanatory power with around 40% of the variance explained. We experimented with variants without disturbing these core results. The model has both implications and applications. In section III we turn to an implication, the existence of regional arms races, and in section IV to an application, an analysis of the effectiveness of military spending.

III. An implication: neighbourhood arms races

Our core regression finds that in determining the level of military spending, governments respond to the level set by their neighbours. We have suggested that the motivation underlying this interdependent behaviour is usually emulation rather than threat. This may make mutual de-escalation of military budgets less sensitive.

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

$$m_i = a_i + b\sum_{j=1}^{n} m_j, \quad \text{where } i \neq j \quad \text{and } n = 1, \ldots, N. \tag{6}$$

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 neighbour. 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. First, consider the case in which this is disturbed by a *unilateral* decision of country A to increase its military expenditure. The new equilibrium levels of spending will rise to E_2 in which, because country B has responded to the initial increase, country A finds that it must further increase its own budget. Next consider the case in which the exogenous component of military expenditure is *common* to both neighbours ($a_1 = a_2 = a$). In this case any initial increase is common, and this triggers responses that raise the new equilibrium levels of spending to E_3.

These two cases illustrate two multiplier processes. For each it is straightforward to calculate the eventual effect of an exogenous increase in military spending. In the second case, in equilibrium the two countries have the same defence burden. Elementary rearrangement of equation (6) yields:

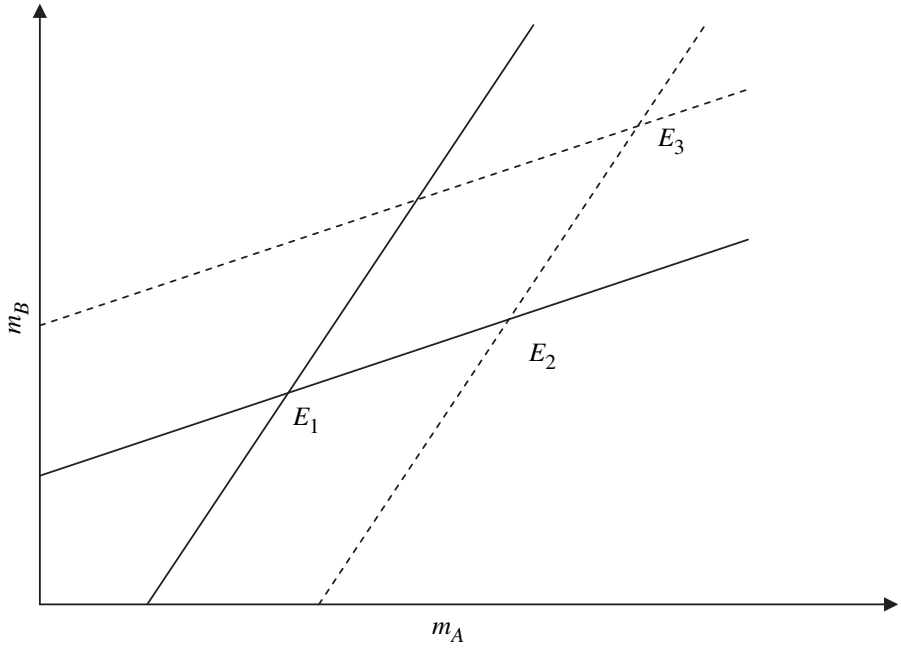

Figure 1. Military expenditure reaction functions

$$m_i = \frac{a}{(1-b)}. \tag{7}$$

Differentiating equation (7) 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):

$$\text{ARM} = \frac{1}{(1-b)}. \tag{8}$$

The ARM applies only if both the country and its neighbours experience a common exogenous increase in military expenditure. If only one country exogenously increases its expenditure, as illustrated in the first case, then there are two ARMs, that for the country with the initial increase (the arms race multiplier for own expenditure, ARMOE), and that for the neighbour (ARMNE). Again, the multipliers can be derived straightforwardly from appropriate rearrangement of equation (6) as:

$$\text{ARMOE} = \frac{1}{(1-b^2)} \quad \text{and} \quad \text{ARMNE} = \frac{b}{(1-b^2)}. \tag{9}$$

Equation (5), which we have estimated in Table 1, column 1, is an elaboration of equation (6). The coefficient on the military expenditure of neighbours, which is found empirically to be 0.1, is an estimate of b. As in the regression military

expenditure is measured as a logarithm, the coefficient is an elasticity: a 1% increase in the spending of neighbours raises own expenditure by 0.1%. The ARM is thus 1.11. That the ARM is greater than unity suggests that where common exogenous influences are important, there is a 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 neighbouring countries indeed face a common exogenous increase in their military spending. We now consider a particularly important one, namely, if neighbours 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, specifically, an increase of 40%. This exogenous increase is augmented by the ARM, so that the equilibrium increase is 44%. In turn, this has implications for the cost of warfare: in the absence of negotiated reductions in postconflict 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. If these high levels of spending persist, their present value could easily exceed the costs incurred during the war. Although both countries have other neighbours, for military purposes each country may regard the other as the only pertinent neighbour for determining the appropriate level of military spending, so that chosen spending is highly interdependent.

Although we have illustrated the ARM through a two-country model, it applies wherever neighbouring countries face a common exogenous shock to their military spending, regardless of the number of countries involved. However, the same does not apply to the ARMOE and the ARMNE. As the number of pertinent neighbours increases, the ARMOE and the ARMNE decline. Generalizing to the n-country case:

$$\text{ARMOE} = \frac{1}{\left(1 - \left(\frac{b}{n-1}\right)^2\right)} \tag{10}$$

and

$$\text{ARMNE} = \frac{\frac{b}{n-1}}{\left(1 - \left(\frac{b}{n-1}\right)^2\right)}. \tag{11}$$

Thus, as the number of neighbours increases, these ARMs converge to the following values: $\text{ARMOE} \to 1$ as $n - 1 \to \infty$ and $\text{ARMNE} \to 0$ as $n - 1 \to \infty$. This convergence is quite rapid as shown in Figures 2 and 3. Given our estimate of b, neighbourhood arms races are thus only of importance in the case of common shocks to the region; spending increases by individual 'rogue' governments do not generate significant neighbourhood effects.

While an international war is intrinsically multicountry, a civil war may be confined to a single country. However, the risk of civil war might rise across a region. For example, during the social breakdown in Albania the huge government

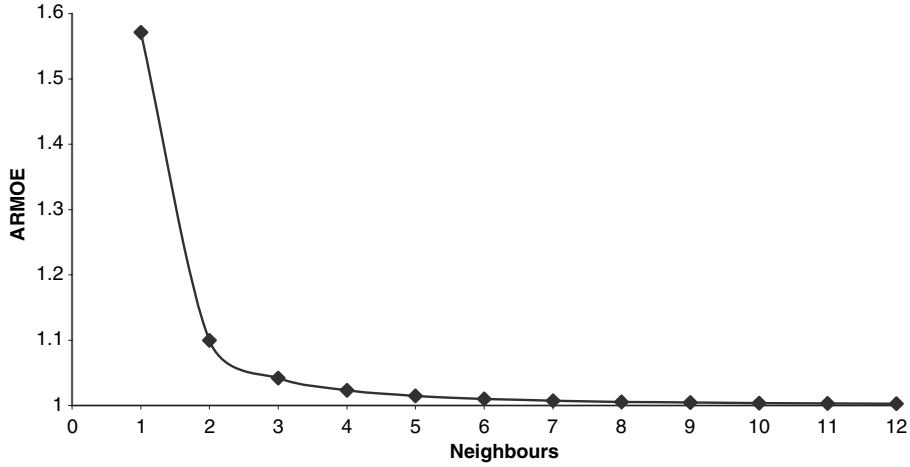

Figure 2. Arms race multiplier own expenditure

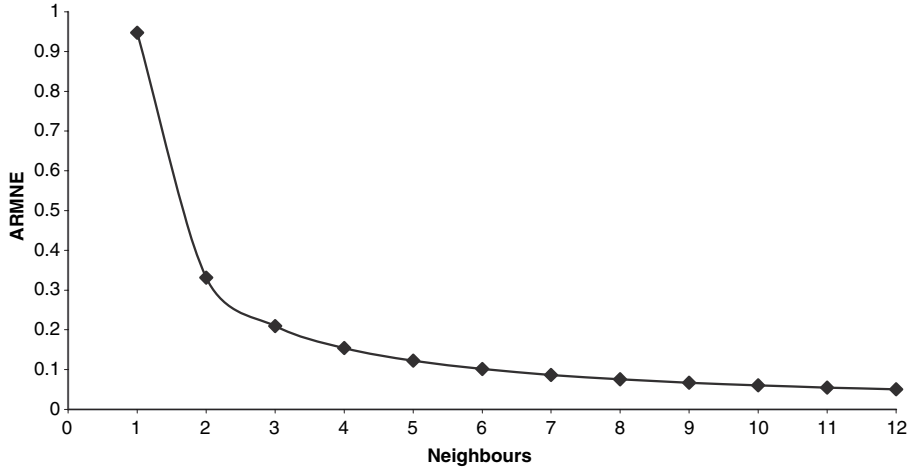

Figure 3. Arms race multiplier neighbour expenditure

stores of military equipment were ransacked, and this made rebellion easier over the entire Balkan area. We thus consider the effect of an increase in the risk of civil war of 10 percentage points across a neighbourhood. Such an increase in risk would directly raise military spending in each country by around 7.3%. This would in turn be increased through the ARM to around 8.1%. Hence, through its effect on the military spending of neighbours, the risk of civil war is a regional public bad.

So far we have considered common adverse shocks: international war and the risk of civil war. We now consider a common favourable shock: aid. Specifically, suppose that aid to Africa was doubled. Recall that about 40% of African military

spending appears to be inadvertently financed by aid. Hence, unless behaviour patterns were to change, a doubling of aid would approximately directly increase military spending by 40%. The ARM would then increase this further to 44%. Equivalently, almost half of current African military spending is either financed by aid or induced by the arms race triggered by this additional finance.

IV. An application: the effectiveness of military expenditure

In section III we quantified the effects of regional military expenditure as if it were entirely a regional public bad. We found that high spending by one country increases spending by neighbours. However, military spending might be socially beneficial if it deters civil war and we now investigate whether there is such an offsetting benefit. Civil war can reasonably be seen as a regional public bad: it reduces growth rates across the region (Murdoch and Sandler, 2002; Collier and Hoeffler, 2004b), and spreads disease (Collier *et al.*, 2003). In section II, we found that governments respond to the risk of civil war by increasing their military expenditure. If this is effective as a deterrent then there is an offsetting positive externality from military spending, generated by the reduction in the risk of civil war. Potentially, military expenditure is therefore a regional public *good*. In determining the net regional externality of military spending – public good or public bad – the key unknown is the efficacy of military spending as a deterrent of civil war. This is the task of the present section.

In Table 2, column 1, we report for ease of reference our core logit regression of the risk of civil war (Collier and Hoeffler, 2004a). We cannot simply introduce military spending into this regression because we have already established that it is endogenous to the risk of civil war, rising in correct anticipation of rebellion. Unless this effect is controlled for, military spending will spuriously appear to increase the risk of rebellion. To allow for this endogeneity, we instrument for military expenditure, adopting an IV procedure. Our first stage, the estimation of the military expenditure function, uses OLS. Assuming normality the natural choice for the second stage is a probit, rather than a logit regression. We apply the two-stage probit least squares procedure as suggested by Keshk (2003). In Table 2, column 2, we repeat our core regression of the risk of civil war using a probit instead of a logit. The regression is scarcely altered by this change in functional form. We then select instruments for military expenditure. Fortunately, as established in section II, there are some powerful influences on military expenditure which can reasonably be seen as unrelated to the risk of rebellion. All the variables included in our core regression of Table 1, with the evident exceptions of being at civil war and the risk of civil war, are reasonable candidates as instruments. For example, as countries differ enormously in the extent of external threats, they differ considerably in their predicted levels of military expenditure. The two-stage results generated by including all the variables of Table 1, column 1, as instruments, less the two noted exceptions, are shown in Table 2, column 3.

TABLE 2

Deterrence effects of military expenditure on rebellion

Estimation method	*1* *Logit*	*2* *Probit*	*3* *Probit 2SLS*	*4* *Probit 2SLS*
ln GDP per capita	−0.950 (0.245)***	−0.460 (0.124)***	−0.649 (0.166)***	−0.622 (0.149)***
$(\text{GDP growth})_{t-1}$	−0.098 (0.041)**	−0.051 (0.022)**	−0.030 (0.027)	−0.027 (0.025)
Primary commodity exports/GDP	16.773 (5.206)***	7.407 (2.456)***	10.306 (3.353)***	10.648 (3.226)***
$(\text{Primary commodity exports/GDP})^2$	−23.800 (10.040)**	−10.160 (4.630)**	−15.622 (6.625)**	−16.867 (6.480)***
Social fractionalization	−0.0002 (0.0001)***	−0.0001 (0.0001)**	−0.0002 (0.0001)***	−0.0001 (0.0001)**
Ethnic dominance (45–90%)	0.480 (0.328)	0.257 (0.168)	0.365 (0.210)*	0.345 (0.193)*
Peace duration	−0.004 (0.001)***	−0.002 (0.001)***	−0.002 (0.001)***	−0.002 (0.001)***
ln population	0.510 (0.128)***	0.247 (0.063)***	0.245 (0.090)***	0.277 (0.085)***
Geographic concentration	−0.992 (0.909)	−0.428 (0.450)	−0.972 (0.569)*	−1.236 (0.547)**
Military expenditure			0.338 (0.233)	0.452 (0.248)*
			$P = 0.148$	
N	750	750	482	570
Pseudo R^2	0.22	0.22	0.27	0.26
Log likelihood	−146.84	−147.48	−96.53	−115.33

Notes: Dependent variable is a bivariate indicator of an outbreak of civil war in any given sub-period 1965–69, . . . ,1995–99. The probit 2SLS procedure is as described in Keshk (2003). All regressions include a constant. Standard errors in parentheses. Values are significant at ***1%, **5% and *10% levels. While there is no standard overidentification test for 2SLS probits, we re-estimated columns 3 and 4 as a linear probability model. These models satisfy the Hansen test, we obtained $\chi^2_4 = 4.481$ ($P = 0.35$) for the model in column 3 and $\chi^2_3 = 4.588$ ($P = 0.205$) for the model in column 4.

So instrumented, the coefficient on military expenditure is insignificant. As, however, it is close to being significant, it is worth considering its sign, which is positive, implying that if anything, military spending *increases* the risk of civil war. As discussed in section II, the military spending of neighbours might potentially be endogenous to the risk of civil war. In Table 2, column 4, we therefore repeat the IV procedure, dropping this variable as an instrument. Far from this amendment rehabilitating the deterrence effect, the sign of the military spending variable remains positive and it becomes significant at 10%: if anything, high military spending aggravates the risk of civil war. The complete absence of any deterrent effect is quite striking as the instruments themselves seem to be good. 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 nonlinear effects in case there should be some optimal level of deterrence, but found no significant relationship.

Thus, although governments increase military spending in an effort to deter rebellion, the expenditure appears to be at best ineffective. Both economics and political science offer possible explanations for this apparently perverse result. Mehlum and Moene (2006) analyse the effect of incumbent military advantage on the incentive to rebel and show that it is *a priori* ambiguous. Although greater government advantage reduces the prospects of success, as in equation (1), it increases the value of success because of the reduced danger of challenge. An increase in government military equipment can thus induce rebellion instead of deterring it. Fearon and Laitin (2003) emphasize the sheer difficulty of military deterrence of rebellion. 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 counterinsurgency. Finally, military spending might inadvertently increase the risk of conflict through its adverse effect on economic growth. Knight, Loayza and Villanueva (1996) find that military expenditure significantly reduces growth, while Miguel, Satyanath and Segenti (2004) show that growth reduces the risk of rebellion. In a companion paper (Collier and Hoeffler, 2006), we investigate the deterrence effects of military spending further by distinguishing postconflict societies. We show that the postconflict context is distinctive, with military spending having significantly *adverse* effects. Any deterrence effect is more than offset by other effects. However, even with this postconflict effect separately distinguished, in other contexts military spending still has no significant deterrence effect.

V. Conclusion: some implications for policy

We have found that the level of military expenditure chosen by a government is influenced both by aid and by the level of spending chosen by neighbouring governments. Where aid is common across a region, as in Africa, it thereby inadvertently has the effect of escalating a regional arms race. Taking the two effects

together, we estimate that in Africa military spending is almost double its level in the absence of aid. Although this is ostensibly a detrimental effect, the increased level of military spending may potentially have helped both to maintain international peace and to reduce the incidence of rebellion. However, we found that the influence of the military spending of neighbours worked through emulation rather than threat, suggesting that the deterrence of international war is usually unimportant as a rationale for military spending. Further, we found that while military spending indeed 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', and so will be oversupplied by national-level decisions. 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. In this situation, the international financial institutions may have a facilitating role as neutral but privileged observers, and may even have a role as external enforcers of regional agreements (see Murshed and Sen, 1995, for a discussion of the scope for International Financial Institutions (IFI) peace conditionality).

The donor community has a further interest in the reduction of military expenditure in aid-recipient countries as, on our evidence, aid leaks into the finance of military spending and inadvertently fuels an arms race. Hence, donors might 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. Finally, we should note that it may be necessary to spend so as to save. Reducing military spending in developing countries will usually involve demobilizing soldiers and this is likely to require initial expenditures on severance packages.[13] Hence, a donor policy of imposing a cap on military spending might have the inadvertent consequence of inhibiting expenditure reduction.

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References

Anselin, L., Florax, R. and Rey, S. (eds) (2004). *Advances in Spatial Econometrics, Methodology, Tools and Applications*. Springer-Verlag, Berlin.

Barrett, D. B. (ed.) (1982). *World Christian Encyclopedia*, Oxford University Press, Oxford.

Barro, R. J. (ed.) (1997). *Determinants of Economic Growth*, MIT Press, Cambridge, MA, and London.

Brzoska, M. (1995). 'World military expenditures', in Hartley K. and Sandler T. (eds), *Handbook of Defense Economics*, Vol. 1, Elsevier, Oxford, pp. 46–67.

[13]However, our results are not contaminated by these demobilization expenditures as they are excluded from the SIPRI definition that we adopt.

Collier, P. and Hoeffler, A. (2002a). 'On the incidence of civil war in Africa', *Journal of Conflict Resolution*, Vol. 46, pp. 13–28.
Collier, P. and Hoeffler, A. (2002b). 'Aid, policy and peace: reducing the risks of civil conflict', *Defence and Peace Economics*, Vol. 13, pp. 435–450.
Collier, P. and Hoeffler, A. (2004a). 'Greed and grievance in civil war', *Oxford Economic Papers*, Vol. 56, pp. 563–595.
Collier, P. and Hoeffler, A. (2004b). 'Conflict', in Lomborg B. (ed.), *Global Crises, Global Solutions*, Cambridge University Press, Cambridge, pp. 129–156.
Collier, P. and Hoeffler, A. (2006). 'Military expenditure in post-conflict societies', *Economics of Governance*, Vol. 7, pp. 89–107.
Collier, P., Elliott, V. L., Hegre, H., Hoeffler, A., Reynal-Querol, M. and Sambanis, N. (2003). *Breaking the Conflict Trap: Development Policy and Civil War*, Oxford University Press, Oxford.
Deger, S. and Somnath, S. (1991). 'Military expenditure, aid and economic development', in Summers L. and Shah S. (eds), *Proceedings of the World Bank Annual Conference on Development Economics*, World Bank, Washington, D.C., pp. 159–186.
Department of Geodesy and Cartography of the State Geological Committee of the USSR (1964). *Atlas Naradov Mira*, Moscow.
Dunne, P. and Perlo-Freeman, S. (2003). 'The demand for military spending in developing countries', *International Review of Applied Economics*, Vol. 17, pp. 23–48.
Fearon, J. and Laitin, D. (2003). 'Ethnicity, insurgency, and civil war', *American Political Science Review*, Vol. 97, pp. 75–90.
Feyzioglu, T., Swaroop, V. and Zhu, M. (1998). 'A panel data analysis of the fungibility of foreign aid', *World Bank Economic Review*, Vol. 12, pp. 29–58.
Gartzke, E. and Jo, D.-J. (2002). The Affinity of Nations Index, 1946–1996. Version 3.0. http://www.columbia.edu/∼eg589/datasets.html.
Gleditsch, N. P., Wallensteen, P., Eriksson, M., Sollenberg, M. and Strand, H. (2002). 'Armed conflict 1946–2001: a new dataset', *Journal of Peace Research*, Vol. 39, pp. 615–637.
Gyimah-Brempong, K. (1989). 'Defense spending and economic growth in sub-Saharan Africa: an econometric investigation', *Journal of Peace Research*, Vol. 26, pp. 79–90.
Hartley, K. and Sandler, T. (eds) (1990). *The Economics of Defence Spending: An International Survey*, Routledge, London.
Hartley, K. and Sandler, T. (eds) (2001). *The Economics of Defence*, 3 Vols, Elgar, Cheltenham, UK.
Hegre, H., Ellingsen, T., Gates, S. and Gleditsch, N.-P. (2001). 'Toward a democratic civil peace? Democracy, political change, and civil war, 1816–1992', *American Political Science Review*, Vol. 95, pp. 33–48.
Jaggers, K. and Gurr, T. R. (1995). 'Tracking democracy's third wave with the Polity III data', *Journal of Peace Research*, Vol. 32, pp. 469–482.
Keshk, O. M. G. (2003). 'CDSIMEQ: a program to implement two-stage probit least squares', *Stata Journal*, Vol. 3, pp. 157–167.
Knight, M., Loayza, N. and Villanueva, D. (1996). 'The peace dividend: military spending cuts and economic growth', *IMF Staff Papers*, Vol. 43, pp. 1–37.
Konrad, K. A. and Skaperdas, S. (1998). 'Extortion', *Economica*, Vol. 65, pp. 461–477.
Looney, R. E. (1989). 'Internal and external factors in effecting third world military expenditures', *Journal of Peace Research*, Vol. 26, pp. 33–46.
Maizels, A. and Nissanke, M. K. (1986). 'The determinants of military expenditure in developing countries', *World Development*, Vol. 14, pp. 1125–1140.
Manski, C. F. (1993). 'Identification of endogenous social effects: the reflection problem', *Review of Economic Studies*, Vol. 60, pp. 531–542.
Mauro, P. (1995). 'Corruption and growth', *The Quarterly Journal of Economics*, Vol. 110, pp. 681–712.

Mehlum, H. and Moene, K. (2006). 'Fighting against the odds', *Economics of Governance*, Vol. 7, pp. 75–87.
Miguel, E., Satyanath, S. and Segenti, E. (2004). 'Economic shocks and civil conflict: an instrumental variable approach', *Journal of Political Economy*, Vol. 112, pp. 725–753.
Murdoch, J. C. and Sandler, T. (2002). 'Economic growth, civil wars, and spatial spillovers', *Journal of Conflict Resolution*, Vol. 46, pp. 91–110.
Murphy, K. M. and Topel, R. H. (1985). 'Estimation and inference in two-step econometric models', *Journal of Business and Economic Statistics*, Vol. 3, pp. 370–379.
Murshed, S. M. and Sen, S. (1995). 'Aid conditionality and military expenditure reduction in developing countries: models of asymmetric information', *The Economic Journal*, Vol. 105, pp. 498–509.
OECD (2001). Overseas Development Assistance, data-file (CD-ROM), OECD, Paris.
Richardson, L. F. (1960). *Arms and Insecurity*, The Boxwood Press, Chicago.
Singer, D. J. and Small, M. (1994). *Correlates of War Project: International and Civil War Data, 1816–1992*. Inter-University Consortium for Political and Social Research, Ann Arbor, MI.
SIPRI (The Stockholm International Peace Research Institute) (2003). *Yearbook of World Armaments and Disarmaments*, Oxford University Press, Oxford.
Skaperdas, S. (1996). 'Contest success functions', *Economic Theory*, Vol. 7, pp. 283–290.
Small, M. and Singer, J. D. (1982). *Resort to Arms: International and Civil War, 1816–1980*, Sage, Beverly Hills.
Smith, R. P. (1989). 'Models of military expenditure', *Journal of Applied Econometrics*, Vol. 4, pp. 345–359.
Smith, R. P. (1995). 'The demand for military expenditure', in Hartley K. and Sandler T. (eds), *Handbook of Defense Economics*, Elsevier, Amsterdam, pp. 70–87.
Smith, R. P. and Dunne, P. J. (forthcoming). 'The econometrics of military arms races', in Hartley K. and Sandler T. (eds), *Handbook of Defense Economics*, 2nd edn, Elsevier, Amsterdam.
Smith, R. P., Dunne, P. J. and Nikolaidou, E. (2000). 'The econometrics of arms races', *Defence and Peace Economics*, Vol. 11, pp. 31–43.
Summers, R. and Heston, A. (1991). 'The Penn World Table (Mark 5): an expanded set of international comparisons, 1950–1988', *The Quarterly Journal of Economics*, Vol. 106, pp. 327–368.
Tavares, J. (2003). 'Does foreign aid corrupt?', *Economics Letters*, Vol. 79, pp. 99–106.
World Bank World Development Indicators (2002). *Data File*, World Bank, Washington, DC.

Appendix

TABLE A1

Descriptive statistics

	Mean	*SD*	*Min.*	*Max.*	*N*
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
Neighbours' 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

TABLE A2

Correlation coefficients

	Milieux	*Ex. threat*	*ln GDP*	*Neighb. milieux*	*ln pop.*	*Dem.*	*Int. threat*	*Int. war*	*Civ. war*
Ex. threat	0.330	1							
ln GDP	0.114	0.200	1						
N. milieux	0.665	0.264	0.090	1					
ln pop	−0.015	0.283	0.015	0.039	1				
Dem.	−0.167	0.123	0.678	−0.198	0.017	1			
Int. threat	−0.031	−0.048	−0.447	−0.024	0.194	−0.321	1		
Int. war	0.346	0.307	0.005	0.226	0.081	−0.052	0.054	1	
Civ. war	0.091	0.065	−0.215	−0.001	0.147	−0.134	−0.207	0.122	1
Israel	0.359	0.208	0.115	0.273	−0.059	0.125	−0.075	0.154	−0.033

TABLE A3

First stage regression

International war	−0.634 (1.121)
Civil war	2.502 (1.043)**
External threat	1.342 (0.767)*
(Neighbours' military expenditure)$_{t-1}$	0.285 (0.133)
ln population	−1.752 (0.237)***
Internal threat	−6.424 (3.588)
1995–99	1.618 (1.118)
Democracy	0.136 (0.096)
ln GDP per capita	−5.881 (0.396)***
Israel	6.934 (2.395)***
UK* Aid language	−0.0012 (0.0005)***
UK* Aid religion	−0.0016 (0.0008)***
US* Aid political similarity	−0.0006 (0.0001)***
Japan Aid* 1/distance	−2.8339 (0.9999)**
N	339
R^2	0.52

Notes: First stage results for the 2SLS results presented in Table 1, column 4. Dependent variable is aid/GDP. The regression includes a constant. Standard errors in parentheses. Values are significant at ***1%, **5% and *10% levels.

Data

The model presented in Table 2 primarily uses data from Collier and Hoeffler (2002b) 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 5-year period. Data sources: World Development Indicators (2003) and OECD (2001).

Civil war

It 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 Small and Singer (1982) and Singer and Small (1994) and according to their definitions Nicholas Sambanis updated their data set for 1992–99.

Democracy

It measures the general openness of the political institutions, it ranges from zero (low) to 10 (high). The data source is the Polity III data set as discussed by Jaggers and Gurr (1995).

Ethnic dominance (45–90%)

Using the ethno-linguistic data from the original data source (Department of Geodesy and Cartography of the State Geological Committee of the USSR, 1964) we calculated an indicator of ethnic dominance. This variable takes the value of one if one single ethno-linguistic group makes up 45–90% of the total population and zero otherwise.

External threat

It 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 Small and Singer (1982) and Singer and Small (1994). We updated this data set by using Gleditsch *et al.* (2002). This resulted in the addition of two international wars: Ethiopia and 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 5-year period.

Geographic concentration

We constructed a dispersion index of the population on a country-by-country basis. Based on population data for 400 km^2 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

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

International war

It 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 Small and Singer (1982) and Singer and Small (1994). We updated this data set by using Gleditsch *et al.* (2002). This resulted in the addition of two international wars: Ethiopia and 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). As the data is only available from 1960 to 1992, we used the growth rates of real PPP-adjusted GDP per capita data from the World Bank's World Development Indicators (2002) 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 (2002). Again, we measure population at the beginning of each sub-period.

Israel

It 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 defence burden. Data for 1960–90 was obtained from the SIPRI and we used data from the Global Development Network for 1991–99 (http://www.worldbank.org/research/growth/GDNdata.htm).

Neighbours' military expenditure

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

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

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 neighbours 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 as the end of the previous civil war. For countries which never experienced a civil war we measure the peace period as the end of World War II until 1962 (172 months) and add 60 peace months in each consecutive 5-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 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 1,000 battle-related deaths (civilian and military) occurred per year. We use mainly the data collected by Small and Singer (1982) and Singer and Small (1994) and according to their definitions updated for 1992–99.

1995–99

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