THE DEMAND FOR MILITARY SPENDING IN DEVELOPING COUNTRIES: A DYNAMIC PANEL ANALYSIS*

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Abstract

With the end of the Cold War the international security environment seemed to have undergone fundamental changes, but estimating demand estimating demand functions for developing countries Dunne and Perlo-Freeman (2003) found little evidence of changes in the underlying relationship. One concern was that the use of cross section data failed to pick up important time series effects. This paper uses static and dynamic panel data methods, for 98 developing countries 1981-1997 and finds evidence of a change in relationship, suggesting that focussing upon cross section studies has indeed limited our understanding of important dynamic processes at work within countries

Keywords: Military Spending, Developing Countries, Demand.

JEL Code: H56, C33

INTRODUCTION

There is a diverse applied literature on the determinants of military spending in developing countries. It has attempted to identify the strategic and economic factors that influence the evolution of military burden, using both cross-country studies and time series analysis of case-studies (Dunne, 1996). With the end of the Cold War, there has been a clear change in the strategic environment, with ramifications far beyond those countries that were directly involved. From a situation of two rival superpower blocks, each inclined to fight proxy conflicts through developing world client states, there is a global US hegemony, selectively used to impose 'solutions' on conflicts in weaker states. The number of external conflicts has greatly diminished, while civil wars have proliferated, fuelled by ethnicity, religion and control of resources (Kaldor, 1999; Collier and Hoeffler, 1998).

Dunne and Perlo-Freeman (2003) was one of the first studies to re-examine the empirical picture using data from after the end of the Cold War, to assess whether this dramatic change in the global strategic environment had altered the pattern of demand for military spending. Using a cross-section model incorporating economic, political and strategic variables, they estimated demand functions for two separate periods, one in the eighties, and one in the nineties, after the fall of the Berlin Wall. Surprisingly, they found little evidence of a change in the pattern of determinants between the two periods.

These cross-section models can help explain the differences in military burden across countries, but the conclusions reached may not carry forward to differences within countries over time. This study develops the analysis by using panel data methods, which allow both the cross sectional and the time series dynamics to be taken into account. This allows a test of whether the determinants of military spending have changed with the end of the Cold War, when the country specific dynamics of the process are taken into account.

The next section reviews the different approaches to analysing the demand for military spending in the literature. The third section then develops the empirical model used in the analysis followed by a discussion of the econometric issues involved in the analysis of panel data and a presentation of the models to be used in the empirical analysis. The sample and data are then discussed in the fifth section, followed by the regression results for static and dynamic panel data estimations in the sixth. The final section then offers some conclusions.

THE DEMAND FOR MILITARY SPENDING

There are two broad groups of empirical studies in the literature on the determinants of military spending. First, those based on the arms race models of Richardson (1960), which are best suited to situations in which countries are in conflict and have often have failed to perform well empirically (Dunne, 1996; Smith, 1989)[1]. Second, there are those studies focusing on a range of economic, political and strategic determinants of military spending, with the most satisfactory empirical analyses tending to take a relatively comprehensive approach. More formal models have been developed from the neoclassical approach, which considers the country or state as maximising a social welfare function with security an integral component (Smith, 1980 and 1995). Most theoretical models lead to similar estimation equations for the empirical analysis, where the demand for military expenditure is a function of economic resources, threats to security, and political factors, such as the nature of the state. A particularly useful approach to measuring the threats to security uses the concept of a 'Security Web' developed by Rosh (1988). This defines neighbours and other countries that can affect a nation's security (such as regional powers) as being part of a country's Security Web, and calculates the degree of militarisation of a nation's Security Web by averaging their military burdens.

The empirical demand studies have found mixed results, but they do tend to suggest that in developing countries, economic conditions are not the most important determinant of military burden. They have also found clear differences across types of countries and types of governments, to the extent that some argue that the determinants are country specific and not amenable to generalisation (Deger and Sen, 1990). This is disputed by Hewitt (1991) who finds common economic and financial determinants across a large sample of countries. Other recent studies include Adams and Ciprut (1994), who analyse the demand for military expenditure in South East Asia, using spending by allies and enemies adjusted for distance as the main security variable, and Batchelor, Dunne and Lamb (2002) who carry out a time-series analysis of South Africa's military spending, using a number of variables relating to South Africa's changing security environment.

Overall, it is clear that a wide range of strategic and economic factors can influence the demand for military spending. Any empirical analysis across countries must attempt to pick these up, but there are likely to be problems in operationalising them.

MODELLING THE DEMAND FOR MILITARY SPENDING

In attempting an econometric analysis of the determinants of military spending, it is important to have some theoretical framework to allow the specification of causality and to assist in determining the functional form, selecting the relevant variables, and testing implied restrictions. Using a formal model also makes the underlying assumptions explicit, allows hypotheses to be properly defined and tested, and allows the number of parameters to be reduced through tests of restrictions. This is normally achieved by using a neoclassical model of the state as a rational actor maximising social welfare subject to a resource constraint. The social welfare function is determined by the state, whether based on individual preferences or on some voting rule, such as the median voter. Military expenditure is then determined by balancing its opportunity cost with the security benefits it provides. Examples of this approach are Smith (1980) and Hewitt (1991).

Defining social welfare to be a function of private consumption C and security S, conditioned on political, strategic, and demographic variables Z:

$$W = W(C, S, Z). \quad (1)$$

The level of security depends, in turn, upon the level of military expenditure M, conditioned on demographic and strategic variables T:

$$S = S(M, T). \quad (2)$$

Maximising the social welfare function subject to a budget constraint,

$$Y = P_m M + P_c C, \quad (3)$$

where P_m and P_c are the prices of M and C relative to an income deflator, gives a demand function:

$$M = D(Y, P_m, P_c, Z, T). \quad (4)$$

This equation can then be rewritten as shares in Y rather than levels to give us the demand function commonly used in empirical work (Smith, 1989, 1995).

To provide an estimable demand function, the income variable needs to be specified, and the political and strategic effects quantified. As in most developing countries specific data on military prices is not available and the share of military spending in GNP (the military burden) is expressed as a function of GNP, of various other economic and strategic variables, and of political variables such as the type of regime. Population is also included to pick up possible public good effects. Following Rosh (1988), we proxy the level of external threat by looking at the country's 'Security Web', defined as all of its neighbours, and any other powers that may be able to affect the country's security. Within each country's Security Web, a subgroup of 'Potential Enemies' is identified with whom the country is in dispute with potential for conflict. This gives two threat variables, the total military expenditure of the country's Security Web (SW)[1] and that of its Potential Enemies (PE)[2]. In most cases, superpowers were left out of a country's Security Web, as it was assumed they would have no realistic way of opposing a superpower militarily. However, a dummy variable, Great Power Enemy (GPE), was included to pick up any relationship of enmity with a superpower. While missing military spending data did lead to the exclusion of some countries, it did not seem sensible to exclude countries due to incomplete data on their Security Web, and judgement was used to assign a reasonable figure for missing country-years[3]. Other strategic factors were also considered, with an index of civil conflict constructed, ranging from zero (no conflict) to four (generalised civil war) for each country-year and an External War dummy (EW) taking the value one if a country was engaged in an all-out war and zero otherwise.

It is widely found that democratic countries spend less on the military than non-democracies (e.g. Rosh, 1988; Hewitt, 1991; Maizels and Nissanke, 1986). Autocratic states are more likely to rely at least partly on the military to retain their grip on power, along with a culture and ideology of militarism to justify their rule. Totalitarian states are also more likely to be able to maintain unjustifiable and inefficient levels of spending by the military and other government departments in pursuance of the interests of a public elite rather than the country as a whole. Rather than creating simple dummy variables to reflect political systems, the POLITY98 database was used to construct a variable that reflected the degree of democracy in a country. This database gives values for democracy and autocracy for each country from the early 19th century, broken down into various subcategories. For this study, the value of the democracy variable for each country-year had the value of the autocracy variable subtracted from it. This variable, henceforth referred to simply as 'Democracy', has a range of –10 (perfect autocracy) to +10 (perfect democracy). Rosh (1988) also hypothesised that countries that were highly integrated in the global economy would find it easier to access finance for arms purchases, leading to higher military expenditure. To capture this a total trade variable (Trade), imports plus exports, was included.

[1] Rosh (1988) uses the military burdens of the Security Web countries, but we follow Dunne and Perlo Freeman (2003) in

ECONOMETRIC ISSUES IN PANEL DATA ANALYSIS

Dunne and Perlo-Freeman (2003) used the above model to estimate cross-section regressions for the demand for military expenditure during and after the Cold War. This tells us a lot about the differences in military burden between countries, but gives no information about the dynamics of the process. It is possible that the way military expenditure responds to changes in variables over time is quite different to the way in which these variables are correlated with military expenditure across countries. One way of understanding the changes in military expenditure over time is to look at case studies of individual countries. However, another approach that allows us a much more general understanding of the process in question is the use of panel data. This allows us to incorporate both cross-section and time-series information, by pooling the time series for the different countries in the sample and choosing a relevant panel data model.

There are a number of possibilities. A pooled regression simply estimates a model of the form:

$$y_{jt} = \alpha + \beta x_{jt} + u_{jt}, \qquad (5)$$

where y is a dependent variable, x an independent variable, α and β parameters and u a random error, on all of the data, countries j =1,2,...N and time t =1,2,...T. This implicitly assumes that all parameters are the same for each country. The main problem is that ignores factors that may be specific to each country. In addition, time-series effects are likely to be drowned out by cross-sectional variation.

The most common panel estimator is the one-way fixed effects estimator, which allows the intercept to differ across groups (countries):

$$y_{jt} = \alpha_j + \beta x_{jt} + u_{jt}, \qquad (6)$$

where the α_j represent country-specific effects. This is equivalent to replacing each observation with its deviation from the group mean over the whole time period, and then using these deviations in the regression. Taking deviations in this way means that only the within-group variation is considered, while the between-group cross sectional relation is factored out. The random effects estimator treats the country-specific effects as random, coming from some probability distribution, and tends to give results in-between the simple pooled estimator and the fixed effects model. However, it has the disadvantage that it is rendered inconsistent by correlation between the fixed effects and the

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using total military spending.

regressors, which makes it particularly unsuitable in this case. The fixed effects model does not share this problem.

When a relatively long time series is available it is possible to introduce dynamics to panel data models. In dynamic models of the form:

$$y_{jt} = \alpha_j + \beta x_{jt} + \lambda x_{jt-1} + u_{jt}, \tag{8}$$

the fixed effect estimator is not consistent as N, the number of groups, goes to infinity for fixed T because of lagged dependent variable bias, which biases λ downwards. It is, however, consistent as T goes to infinity, so that for samples where T is large, the bias is small. If the parameters differ over the groups then there is a further heterogeneity bias which is not removed by letting either N or T tend to infinity (Pesaran and Smith, 1995) .

While we have time series data in this study, the number of years (T) is limited. Initially, therefore, we use a static model, without a lagged dependent variable[4]. An alternative approach to dealing with the dynamics is to use the method developed in the context of samples with small numbers of time series observations. This takes the estimation equation and differences it to transform out the country specific effects, which allows a dynamic specification in differences with a lagged dependent variable. As the differencing induces a bias in the coefficient on the lagged dependent variable, due to the correlation between it and the unobserved fixed effects in the residual, an instrumental variable method must be adopted. The Arellano and Bond (1991) generalised method of moments (GMM) technique uses lags of the endogenous variables at time t-2 and earlier as instruments to give unbiased and consistent estimates of the coefficients. This requires that the differenced equation does not exhibit second and higher order autocorrelation.

SAMPLE AND DATA

To estimate the model, a panel of time series data for each country for the period 1981-97 was constructed. The focus is on developing economies and excludes the portion of the industrialised world that forms or formed part of the stable alliances systems. This still leaves a highly heterogenous group: sub-Saharan Africa, semi-industrialised South America, the oil-rich Middle East, the population giants of China and India, etc... Data for military spending, national income, trade and population are from the American Arms Control and Disarmament Agency (ACDA). A country was included if there were at least 8 valid observations out of the 17 years, which gave 98 countries, and 1525 observations.

This data came from two separate ACDA yearbooks, (for 1991-92 and 1998), which creates a number of difficulties. First, the data for 1981-86 had to be re-based to 1997 in line with the rest of the data. In a few cases the relevant exchange rate and price figures were not available and the US deflators were used as an estimate[5]. Secondly, ACDA re-estimate their data between different editions of their yearbook, which can introduce errors when chaining together the data from two separate yearbooks. There is little that can be done about this other than to note that this is unlikely to bias our estimates as the errors are unlikely to be systematic. Four separate conflict databases were used to construct the conflict variables and to identify Potential Enemies: the Dyadmid database of dyadic militarised interstate disputes, the KOSIMO database of violent and non-violent conflicts, the CASCON database of conflict case-studies, and the Uppsala University Department of Peace and Conflict Research conflict database. As noted, data on democracy is taken from the POLITY98 database of democracy and autocracy.

Figure 1 plots the average military burden for the sample from 1981 to 1997, and shows it peaking in 1983, then following a downward trend (with an upward blip in 1990, due to Iraq's invasion of Kuwait), and then flattening out after 1993. The averages for the Security Web military spending and Potential Enemies' military spending, are shown in Figure 2. The average Security Web total does not change as much and the particularly large blip in 1990 is the result of Iraq entering the Security Web of several extra countries in that year due to the invasion of Kuwait. The Potential Enemies total by contrast declines after 1990, suggesting a general lessening of interstate hostility.

<Figure 1: Average Military Burden>

<Figure 2 Average military spending of Security Web and Potential Enemies>

PANEL DATA ESTIMATES

Using the fixed effects model, log military burden was regressed on External War, Civil War, Great Power Enemy, Democracy, log GNP, log Population, log Trade, log Security Web military spending and log Potential Enemies military spending. The results are given in Table 1 below. In creating the Security Web variables, Potential Enemies expenditure was included in the Security Web value, to see if additional effects could be observed for spending by more hostile powers. An alternative to this is to treat the categories of non-hostile and hostile neighbours separately. Model 2 includes the Potential Enemies variable and the Others variable, which consists of the military spending of all those countries in a Security Web that are not Potential Enemies of the country concerned. The results show little difference between the models, except that the Security Web variable is negative, though insignificant, in the first model, while the Others variable (i.e. non-hostile expenditures), is positive and significant in the second. The Potential Enemies variable is positive and highly significant in both. While the effect of Potential Enemies military spending seems fairly unambiguous, however, these results are difficult to interpret in terms of the effects of military expenditure by non-hostile neighbours[6]. There is very little to choose between the two specifications.

<Table 1 here>

Overall, the results are reasonably encouraging. Significant results are obtained for External War, Civil War and Potential Enemies (positive) and for Democracy and Population (negative). Given the fact that the Civil War variable takes values from 0 to 4 and External War from 0 to 1, these coefficients are roughly comparable[7]. In addition, log Trade is significant and negative, which is in keeping with Rosh (1988)'s findings. Great Power Enemy is positive but not significant.

The coefficient on log GNP is clearly insignificant and, as the dependent variable is the log of military burden, this suggests that military spending rises more or less in proportion to income across countries. Population has a significant negative impact on military burden, suggesting either that a large population is considered to offer some autonomous security in itself, or that small countries have to spend more on hi-tech weaponry as they cannot rely on a large army. Another explanation could be that a higher population generates greater additional demand for civil consumption than it does security requirements.

There are two issues that arise in the analysis. First, whether we have dealt with the possible dynamics in a reasonable manner using the simple fixed effects model and second, whether or not there has been a structural break in the relationship caused by the end of the Cold War. The next section considers an alternative way to treat the dynamics.

DYNAMIC EFFECTS IN PANELS

To estimate the dynamic model, the Arellano and Bond (1991) technique is used in Stata 7. This differences the variables and provides estimates for the dynamic model. This is done in two steps: the first is used for inference on the coefficients, and the second for inference on model specification. For unbiased and consistent estimates we need the differenced equation to be free of second or higher order autocorrelation. The results in Table 2 suggest that this is the case. The validity of the instrument set is checked using the Sargan test, based on the correlation between the instruments and the residuals. This is asymptotically distributed as chi-squared under the null hypothesis and the results suggest that the instrument set and the residuals are not correlated.

The results in Table 2 show that, in both steps, it is not possible to reject the null hypothesis of no second order autocorrelation, but in the first step the Sargan test rejects the null hypothesis that the overidentifying restrictions are valid. While the second step Sargan test fails to reject the null hypothesis, it is possible that the first stage results indicate heteroscedasticity, and for this reason the heteroscedasticity robust t-ratios are also reported. The procedure will by default use all available lags as instruments, which can lead to a problem of overidentification. To check if this was a problem, the number of lags considered was reduced to two and the results were found not to be significantly affected.

<Table 2>

When the dynamics are taken into account, the results suggest that the growth of military burden is still influenced by both economic and strategic factors. The coefficient estimates show a significant effect of the lagged military burden, with a coefficient of around 0.7, and significant coefficients for log Trade, log Security Web, log Potential Enemies, and External War. There are some interesting results when compared with the fixed effects model. External war has a negative impact on the growth of military burden, possibly reflecting the fact that in the time series dimension countries may increase military spending after a conflict ends to replace lost equipment and to better prepare themselves for future conflict[8]. In addition, the problem of a negative effect of the Security Web variable found in the fixed effect model is no longer apparent, as it now has a significant positive coefficient. This does seem to suggest that the use of dynamic panel data models can improve upon simple static ones and provide valuable insights into the determinants of military spending.

STRUCTURAL BREAKS AND THE COLD WAR

There are two ways in which the regression may change between the periods: the group effects, that is the country dummies for the fixed effects estimator, may be different and/or the slope coefficients for the independent variables may be different. We are primarily interested in changes in the slope coefficients, as a change in the country dummies might indicate that baseline threat perceptions have changed for some or all of the sample, but not necessarily a change in the pattern of demand. Furthermore, the observations for some of the countries in the sample only begin in 1988 or 1989, so the Cold War country dummy variables for these are not very meaningful.

Dividing each country into two periods: 1981-1989, and 1990-1997 and estimating two separate fixed effects regressions, gave a test statistic for equality of the variances of $F(644,668)= 1.076$, which is insignificant even at the 10% level. This means the standard tests for structural breaks can be used. There are two ways in which to do this. Firstly, assume that the individual country effects are the same for both periods and test for equality of the coefficients on the regressors. Secondly, allow the intercepts to vary between the periods and test a model with equal slopes against one with different slopes in the two periods.

The first test is performed by introducing slope dummies for each of the independent variables. When this is done, the period dummy D is clearly insignificant, but there are highly significant coefficients on the slope dummies for Civil War and Population. The effect of Civil War in the later period is significantly stronger, as is the negative population effect. The slope dummies (and period dummy) are jointly highly significant, with an F-test of the joint zero restrictions of these variables giving $F(9,1393)=3.38$, which is significant at the 0.1% level of significance. Thus the hypothesis that the coefficients of the regressors are the same in both periods is strongly rejected. The fact that Civil War is found to have a stronger effect in the Post Cold War period gives some support to the hypothesis that internal factors have become more important, relative to external factors, since the end of the Cold War.

To perform the second test, for a change in the coefficients of the regressors with the intercepts allowed to vary, the sample was re-stratified, breaking each country's data into two separate groups, one for the Cold War observations and one for the Post Cold War observations. To obtain the restricted model, with equal coefficients on the regressors, but different fixed effects in the two periods, a single fixed effects model was estimated on this re-stratified panel. The unrestricted model, where both intercepts and slopes are allowed to change, was obtained by running separate fixed effects models for the two periods. The two models were compared by looking at the residual sums of squares for each, and performing an F-test. This gave F(9,1294)=10.9, which is highly significant. Again, the null hypothesis of equal coefficients between the periods is strongly rejected.

The results of the separate regressions for the two periods are shown in Table 3. The Cold War period results seem curious, with only three variables, GDP, Civil War and Potential Enemies variables significant, and a negative coefficient on the Civil War variable. The Post Cold War results are more like the overall results, though the Potential Enemies variable is no longer significant. The Democracy variable is barely significant in the Post Cold War model and is insignificant in the Cold War model. These results are disappointing, but this may be due to the shortness of the two separate panels. The fixed effects model only picks up variations in the variables within each country over time and there may be insufficient variation within a short period in many countries for the effects of the variables to be detectable. Over the full 17-year period, however, the variables have a chance to vary enough to give meaningful results[9].

<Table 3 here>

Given the very large overall size of the samples, a sensible way to compare all four models is to use the Schwarz-Bayesian Criterion (SBC), which in such cases penalises over-parameterisation more heavily[10]. This suggests that the final model is preferred (see Table 4 below).

<**Table 4 here** >

Overall, these results provide strong evidence for a change in the pattern of demand for military spending since the end of the Cold War. However, it is not easy to interpret the nature of this change, and its significance may be reduced by the shortness of the panels for the two separate periods.

CONCLUSIONS

This paper has estimated static and dynamic panel data models of the demand for military expenditure in developing countries. The fixed effects model found that both external and civil wars were major determinants of military expenditure across countries, together with military spending by potential enemies, suggesting that countries in general do respond to changes in military spending by their rivals. Population had a significant negative effect and there was no evidence that the overall level of income affects military burden one way or the other. Democracy was found to have a negative effect and, as the period in question involved many countries that made the transition to democracy, this suggests that regime changes may have had an important effect on military posture.

When dynamic panel methods were used, the results were interesting and showed both differences from and similarities to the fixed effects model results. There was the expected significant positive effect of lagged military burden and the Security Web variable. One surprising result was a negative sign on the external war variable, but this may reflects some countries spending most heavily to rearm after a conflict.

Tests for a structural break using the fixed effects model showed strong evidence of a change in the demand equation after the end of the Cold War, with the hypothesis that the slope coefficients were the same for both periods strongly rejected. Civil War was found to have a significantly higher coefficient in the second period, giving some support to the hypothesis that internal factors have become more important since the end of the Cold War.

Overall, these results do suggest that focusing upon cross section studies in the demand for military spending has limited our understanding of the dynamic processes at work within countries. Panel data estimation methods provide a valuable tool for future research, particularly when they can deal with the dynamics in a reasonable manner.

Appendix 1: Data Sources and Construction of the Security Web

Data Sources

ACDA World Military Expenditures and Arms Transfers 1991-1992
ACDA World Military Expenditures and Arms Transfers 1998
Dyadic Militarised Interstate Disputes (DYMID1.0), Zeev Maoz, Tel-Aviv University, August 1999, available at http://spirit.tau.ac.il/~zeevmaoz/
Cascon historical database of conflict cases, 1999, available at http://web.mit.edu/cascon
Polity98 Dataset on democracy vs. Autocracy, Kristian S. Gleditsch, 2000, available at http://k-gleditsch.socsci.gla.ac.uk/Polity.html
Armed Conflict, 1989-98, Wallensteen, P. and Sollenberg, M., University of Uppsala Department of Peace and Conflict Research, available at http://www.pcr.uu.se/data.htm, based on data published in *Armed Conflict, 1989–98*, Wallensteen, P. and Sollenberg , M., Journal of Peace Research, Vol. 36, No. 5, 1999.
The KOSIMO violent and non-violent conflict databank, The Heidelberg Institute of International Conflict Research, 2000, available at http://www.hiik.de/en/kosimo/kosimo.htm.

Dataset

A spreadsheet containing all the military expenditure, military burden, income, population, Security Web, Potential Enemies, Enemies, Great Power Enemies and other relevant variables is available on request. Details on the Security Web, Potential Enemies and Enemies of each country in the study, as well as the External and Civil War status and GPE status of each country are also available.

Countries missing from Security Webs

As has been noted, there were a few countries for whom military expenditure data was so completely lacking that it did not seem reasonable to include figures for their expenditure in their neighbours' Security Web totals for certain years. These are as follows:

Afghanistan 1989-97
Angola 1981-82
Cambodia 1981-90
Cape Verde 1984-88
Laos 1981-82, 1987-90
Lebanon 1987-88
Liberia 1989-97
Somalia 1991-97
Vietnam 1981-85, 1987-88

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Figure 1: Average Military Burden

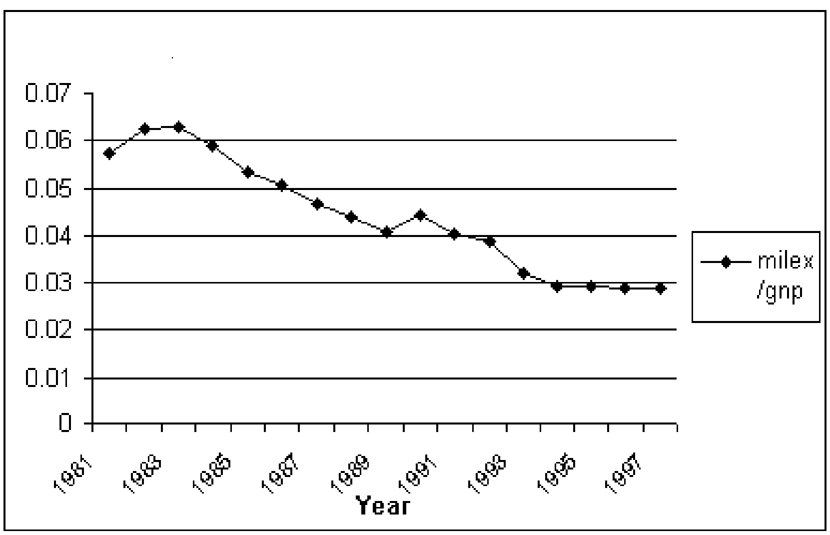

Figure 2 Average milex of Security Web and Potential Enemies

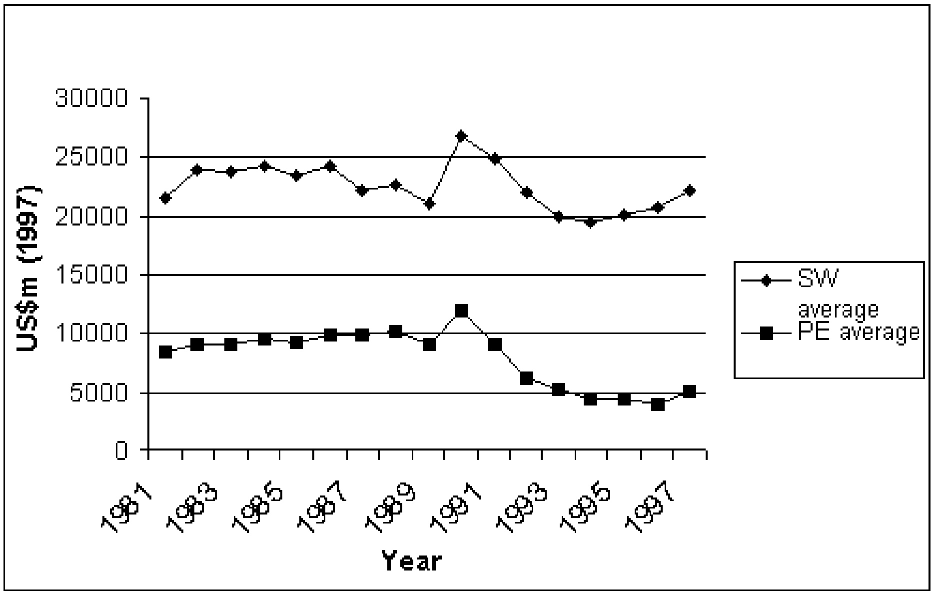

Table 1 Regression Results for Fixed Effects Model

	Model 1	**Model 2**
Variable	**Coefficient**	**Coefficient**
External War	0.60 (8.8)	0.60 (8.8)
Civil War	0.11 (9.4)	0.11 (9.4)
Great Power Enemy	0.089 (1.0)	0.12 (1.4)
Democracy	-0.014 (-5.5)	-0.014 (-5.6)
log Population	-0.33 (-4.9)	-0.31 (-4.7)
log Trade	-0.036 (-1.9)	-0.043 (-2.2)
log GNP	-0.000 (-0.0)	-0.011 (-0.3)
log Security Web milex	-0.027 (-1.5)	
Log Potential Enemies milex	0.041 (7.9)	0.044 (8.0)
Log Others milex		0.032 (2.4)
R-bar squared	.86	.86
Standard Error	.34	.34
Log Likelihood	-453	-451
Estimated autocorrelation	.67	.67

Notes: t ratios in brackets

Table 2: Dynamic Panel Estimation Results

Variables			
Differenced: Log Military Burden (-1)	**Coefficients** 0.688	**T ratios** 14.3	**Robust** 7.8
log Population	-0.180	-1.2	-0.9
log Trade log GNP	0.107 -0.120	3.2 -1.6	1.4 -1.1
log Securty Web milex	0.051	2.5	1.9
log Potential Enemies milex	0.026	3.9	2.0
Levels:			
External War Civil War	-0.055 0.003	-2.2 1.6	-1.7 1.2
GPE	0.009	0.6	0.6
Democracy	0.000	-0.6	-0.4
Constant	-0.003	-0.6	-0.4
N=1215			
Sargan Chi-sqared (119)	174.36	P=0.0007	
AR(1)	-10.62	P=0.0	
AR(2)	-0.95	P=0.342	
Second step results:			
Sargan Chi-sqared (119)	89.64	P=0.9795	
AR(1)	-6.05	P=0.0	
AR(2)	-1.14	P=0.254	

Table 3 Separate Cold War and Post Cold War regressions

	Cold War		Post Cold War	
Variable	Coefficient	T ratio	Coefficient	T ratio
External War	0.051	0.6	0.576	5.8
Civil War	-0.033	-1.9	0.108	7.1
Great Power Enemy	0.216	1.0	1.036	5.1
Democracy	-0.004	-1.1	-0.007	-1.8
log Population	-0.060	-0.7	-1.024	-4.6
log Trade	-0.015	-0.6	0.157	2.8
log GNP	-0.173	-3.3	-0.189	-1.5
log Security Web milex	0.029	1.4	0.011	0.2
log Potential Enemies' milex	0.021	2.6	0.015	1.6

Table 4 Values of Schwarz-Bayesian Criterion for different models

Model	SBC
Same intercepts, same slopes in both periods	-844.442
Same intercepts, different slopes	-859.275
Different intercepts, same slopes	-718.75
Different intercepts, different slopes	-698.884

Endnotes

[1] More recently, this approach proved successful in analysing the military spending of pairs of countries such as India and Pakistan who are both engaged in an enduring rivalry, and for whom the other represents the overwhelming security issue but failed in the case of Greece and Turkey. (Dunne, Nikolaidou and Smith, 2002; Kollias and Makrydakis, 1997).

[2] The categories are nested so that the PE total is also included in the SW total. Thus in the regression analysis, the coefficient of PE will indicate the additional effect of a country being a rival rather than a friendly or neutral neighbour. Dunne and Perlo-Freeman (2003) used a third sub-category of Enemies, a subset of Potential Enemies, but as the distinction between Enemies and Potential Enemies never proved significant, this was omitted from the current study.

[3] Usually, the most recently available figure for military burden was applied to the current level of GNP, sometimes a subsequent figure was used as a best guess and occasionally, missing years were interpolated when there had been a big change. This can be justified both on the basis of necessity and because the aggregation involved in the construction of the variable makes these computations unlikely to significantly affect the final figure. Also, one could argue that it is the sort of process neighbouring countries would have to do in assessing the security threat of a country with non-transparent defence expenditure.

[4] A potential problem with a static model is that variables such as military burden, GNP and population tend to be I(1) for most countries. However, when a static fixed effects model, without a lagged dependent variable, is used for I(1) variables, the coefficient estimates are consistent, although their interpretation is not entirely straightforward. Smith (2000) describes them as the 'long-run average' coefficients.

[5] For communist countries, ACDA data uses PPP exchange rates, so this was not an issue.

[6] One possible explanation for the apparent paradox could be the nature of the log transforms of the variables. Because in many cases Security Web etc. military spending was zero, one could not simply take LSW = log (SW). In fact LSW = log (SW+1) was used (where SW is measured in millions of US$1997)., and similarly for Potential Enemies and Others. To see if this may have been the cause of the anomalous results, other specifications were tried, such as LSW = log (SW+0.00001), LSW = log (SW+1000) and not taking logs at all. The Potential Enemies variable was always highly significant and positive in any form. The significance level of the Security Web and Others variables varied. The sign of Security Web was always negative, the sign of Others was became negative for large added constants and in the linear case. Thus it is possible that the explanation lies in the precise specification.

[7] An F-test accepts the restriction that the coefficient on external war is four times the coefficient for civil war, which would mean the effect of an all-out external war and an all-out civil war are equal.

[8] For example Argentine military spending peaked sharply in 1983, as they rearmed following their defeat in the Falklands/Malvinas conflict.

[9] One particularly curious feature is the fact that External War is only significant in the Post Cold War sample, the exact opposite of the cross-section case. The result makes more sense if we look at the wars that actually occurred. The biggest of these was the Gulf War, which led to enormously increased military spending by Iraq and Kuwait in 1990-91, contributing to a significant coefficient in the fixed effects model. Looked at in the cross-section however, both countries would have an average value of External War of 2/8=0.25. Most countries had EW=0 for the Post Cold War period, and in having a positive value, Iraq and Kuwait are grouped with countries such as Peru and Ecuador, who had relatively low military burdens. Thus it is quite understandable that we should not get a significant coefficient in the cross-section.

[10] This criterion is given by: SBC = Maximised Log Likelihood – Number of Parameters * Ln (Total Observations)