

IMF WORKING PAPER

© 1993 International Monetary Fund

This is a Working Paper and the author would welcome any comments on the present text. Citations should refer to a Working Paper of the International Monetary Fund, mentioning the author, and the date of issuance. The views expressed are those of the author and do not necessarily represent those of the Fund.

WP/93/18

INTERNATIONAL MONETARY FUND

Fiscal Affairs Department

Military Expenditures 1972-1990:
The Reasons Behind the Post-1985 Fall in World Military Spending

Prepared by Daniel P. Hewitt 1/

Authorized for distribution by Ke-young Chu

March 1993

Abstract

World military expenditures have fallen by over 20 percent in proportion to GDP from 1985 to 1990. This study examines the determinants of military expenditures in 125 countries during 1972-90 to ascertain what factors may be behind the recent decreases. Economic decline among developing countries in the 1980s and among industrial countries in the later part of the decade emerges as one possible factor. A second is the move towards more democratic regimes, which could diminish support for the military. A third factor is the improved world security situation and the concomitant decrease in military aid by the former major cold war combatants.

JEL Classification Nos.

H56

1/ The views expressed in this paper do not necessarily represent those of the International Monetary Fund. Thanks to Tarja Papavassiliou for data preparation and thanks to Boris Bravo-Ureta, Ke-young Chu, Shahbaz Khan, and Subhash Ray for their comments. All errors are solely the responsibility of the author.

	<u>Contents</u>	<u>Page</u>
	Summary	iii
I.	Introduction	1
II.	Trends in World Military Expenditures, 1985-1990	1
III.	The Determinants of Military Expenditures	7
	1. The demand for military expenditures: econometric methodology	7
	2. Empirical results	11
IV.	Reasons Behind the Post-1985 Fall in Military Expenditures	15
	1. Financial/economic factors	16
	2. Political changes and security factors	16
V.	Conclusions	20

Tables

1.	World Military Expenditure as Percent of GDP, 1985-90	3
2.	World Military Expenditure in Billion 1990 Dollars, 1985-90	4
3.	World Military Expenditure Shares, 1985-90	4
4.	Military Expenditure in Percent of Central Government Expenditure	6
5.	Central Government Expenditure in Percent of GDP, 1985-90	6
6.	Three Stage Least Square Estimations, 1972-90	10
7.	Two Stage Least Square Estimations, Adjusted Data, 1972-90	13
8.	Growth of Real GDP, 1985-90	17
9.	Summary Statistics of Political Variables	19
10.	Interaction Between Political Variables and Military Expenditures	19

Appendices

I.	Military Expenditure Data	21
II.	A Public Choice Model of Demand for Military Expenditure	23
III.	Disaggregated Empirical Results	29

Appendix Tables

11.	Country Rankings and Ratios of SIPRI Military Expenditure to GDP, 1980-90	32
12a.	Fixed Effects Estimations, Adjusted Data, 1972-90	34
12b.	Between Estimations (Means), Adjusted Data, 1972-90	35
13.	Means, Maxima, and Minima, 1972-90	36

References	37
------------	----

Summary

After increasing during the first half of the decade, world military expenditures as a proportion of GDP have fallen steadily since 1985. For the more than 120 countries covered in this study, military expenditures fell from an estimated 5.6 percent of GDP in 1985 to 4.3 percent, a decrease of 23 percent. In industrial countries military expenditures fell to 3.4 percent of GDP in 1990 from 4.4 percent in 1986, and in Eastern Europe and the former Soviet Union (FSU), from 14.6 percent of GDP in 1985 to 13.1 percent. Over the same period military spending in developing countries dropped from 5 percent of GDP to an estimated 3.8 percent. In the different regions, the North African countries decreased military spending to 3.9 percent of GDP in 1990; Middle Eastern countries, to 8.1 percent; the Asian developing countries, to 3.5 percent; Western Hemisphere developing countries, to 2.1 percent; and in Sub-Saharan Africa military spending increased slightly to 3.2 percent of GDP.

Empirical findings confirm that financial and economic variables influence military expenditures. Econometric analysis of these determinants suggests several factors that might explain the observed drop in military spending. Military expenditures tended to increase with GDP, population, inflows of external financing (either directly or indirectly through increasing government spending), and to be higher in countries that have a high ratio of central government expenditures to GDP. Small low-income and heavily indebted countries are found to generally spend less. Therefore, the decline in military spending after 1985 can be attributed to the slowdown in economic growth in developing countries throughout the 1980s and the decrease in economic activity in the industrialized countries in the latter part of the decade.

Political factors are also found to have a strong impact on military spending decisions. Democratic countries spend the least. Countries involved in international war spend the most, followed by those engaged in civil war; monarchies, military governments, others (mostly one-party states), and socialist countries follow. The profound political changes of the past half-dozen years would therefore be expected to have a strong effect on military expenditure policies. The changes in Eastern Europe and the FSU are well known. In addition, 8 new democracies emerged between 1983 and 1989 replacing 7 military governments. Since 1990, 15 countries have either fully implemented or made moves toward democratic government. In most of these countries military expenditures relative to GDP fell from 1985 to 1990, due, at least in part, to internal political changes. Other contributing factors are the improved world-wide security environment and the fall in military assistance.

The other important factors are the improved world security environment and a fall in military assistance. For instance, among countries that did not shift political categories, the majority of the countries in all groups lowered their expenditures, probably in reaction to these factors.

I. Introduction

Data presented in this paper indicates that a substantial drop in world military expenditures has occurred in recent years. In proportion to GDP, military spending fell by about 23 percent from 1985 to 1990. In 1990, military expenditures are estimated to be about \$950 billion for the over 120 countries considered in this study, however, if the same level of expenditures relative to GDP existed in 1990 as in 1986, expenditures would have been \$1,225 billion. What is perhaps even more surprising is that this drop in expenditures for the world as a whole exceeds that of the U.S.A. and the Former Soviet Union (FSU), where expenditures fell by less than 20 percent as a proportion of GDP.

Questions remain as to whether this represents the beginning of a sustained downward trend in world military expenditures or a temporary aberration. In order to gain insights into future prospects and to ascertain the likely impact of key variables, a careful examination of past events could serve as a helpful guidepost. Thus, it is useful to examine the determinants of military expenditures in recent years.

This study offers a variety of econometric estimates of the determinants of military expenditures in 125 countries over the period 1972-90. The results are then used as a basis to investigate why military expenditures have fallen in recent years. To a large extent, this paper updates and improves on the analysis in Hewitt (1992). The differences are, first, the analysis is extended by two years, 1989 and 1990, and concentrates on the trends from 1985 to 1990 in more detail. Second, the present study provides estimates for disaggregated groups of countries. Third, the econometric analysis is improved though introducing corrections for autocorrelation within each country and for heteroskedasticity between countries.

The paper is organized in the following manner. Section II is a discussion of the trends in world military expenditures. Section III discusses the econometric methodology and the main empirical results. Section IV examines factors that may have contributed to the decrease in military spending between 1985 and 1990. Section V concludes. Appendix 1 describes the data; Appendix 2 provides a more detailed description of the econometric model and methodology; and Appendix 3 discusses the disaggregated results. Since Hewitt (1992) offers a reasonably comprehensive review of the literature, this paper omits this section.

II. Trends in World Military Expenditures, 1985-1990

In the aftermath of the cold war, many analysts speculated that military expenditures in the U.S. and the FSU would plummet, while the impact on the rest of the world might go in either direction. In fact, considerable political resistance to decreases in the U.S. and the FSU has stalled major changes. Consequently, military expenditures in both have not lived up to expectations, falling by 15 percent in the U.S. and by 18 percent in the FSU in proportion to GDP. The extent to which military expenditures will fall in the future is uncertain.

Surprisingly, the average decrease in military expenditures in the rest of the world has exceeded that of the U.S. and the FSU. From 1985 to 1990, the world ratio of military expenditures to GDP fell by 23 percent from 5.6 percent of world GDP to 4.3 percent (Table 1). 1/ The reduction was widespread. Almost all regions on average decreased military expenditures significantly (by 10 percent or more). Among the 124 countries for which data was available, a total of 64 countries decreased military expenditures in proportion to GDP, 40 countries did not change military expenditure in proportion to GDP appreciably, and 20 increased military expenditures in proportion to GDP by more than 10 percent (Appendix Table 11).

Total world military expenditures (in 1990 US dollars) rose from \$842 billion in 1985 to \$941 billion in 1990, remaining virtually stable from 1986 through 1990 (Table 2). If 1990 military expenditures had been 5.6 percent of GDP, they would have reached \$1,225 billion. 2/ In contrast, between 1980 and 1985, total world military expenditures increased as a proportion of GDP from 5.2 to 5.6 percent. From 1980 to 1985, 48 countries decreased military expenditures significantly in proportion to GDP, 39 kept expenditures at approximately the same proportion of GDP, and 38 increased military expenditures in proportion to GDP by 10 percent or more.

Military expenditures in the industrial countries fell by 23 percent to 3.4 percent of GDP in 1990, 58 percent of total world military expenditures (Table 3). As percent of central government expenditures (CGE), military expenditures dropped from 15 percent in 1985 to 12 percent in 1990 and the overall level of CGE fell moderately in proportion to GDP. If the industrial countries had maintained the same proportion of military expenditures to GDP in 1990 as existed in 1985, they would have been \$715 billion, \$165 billion higher than they actually were. Military expenditures in proportion to GDP remained highest in Eastern Europe, 13.1 percent and accounted for 27 percent of total world military expenditures. However, military expenditures in Eastern Europe decreased by 1.5 percentage points of GDP.

1/ Data on military expenditures is derived mostly from the Stockholm International Peace Research Institute (SIPRI), see Appendix I. Although the accuracy of this data is unknown, the trends in data are probably more reliable.

2/ The dollar figures are derived using official exchange rate. The problems with this technique are well known, see Hewitt (1992) for a fuller analysis.

Table 1. World Military Expenditure as Percent of GDP, 1985-90

	1985	1986	1987	1988	1989	1990	1972-90 Average	1972-88 Average 11/
Total	5.6	5.3	5.2	4.8	4.6	4.3	5.1	4.9
Industrial 1/	4.4	4.1	3.9	3.6	3.5	3.4	3.9	3.9
Eastern Europe 2/	14.6	14.9	15.1	14.7	13.3	13.1	12.4	9.9
Developing countries	5.0	4.8	4.6	4.2	3.9	3.8	5.2	5.0
Asian developing 3/	4.4	4.3	4.1	3.8	3.7	3.5	5.7	4.9
Middle East 4/	11.0	9.7	9.6	9.2	8.7	8.1	10.0	10.1
North Africa 5/	5.8	5.4	4.7	4.6	4.4	3.9	7.2	7.6
Sub-Saharan Africa 6/	3.1	3.4	3.6	3.5	3.4	3.2	3.2	3.1
Western Hemisphere 7/	2.0	2.2	2.0	1.9	1.8	1.8	2.1	2.2
Miscellaneous categories of developing countries:								
Net creditor nations 8/	9.2	7.8	7.2	7.3	6.6	6.1	8.9	8.7
Heavily indebted 9/	2.1	2.3	2.2	2.0	1.9	1.8	2.6	2.3
Small low-income 10/	3.0	2.9	2.9	2.8	2.7	2.7	2.7	2.8
Memorandum:								
Eastern Europe other than U.S.S.R. and East Germany	3.3	3.4	3.3	3.2	2.5	2.8	3.4	...
Total number of countries	124	124	123	122	121	120		125

Sources: SIPRI; and staff estimates.

1/ Australia, Austria, Belgium, Canada, Denmark, Finland, France, Federal Republic of Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States.

2/ Bulgaria, Czechoslovakia, German Democratic Republic, Hungary, Poland, Romania, U.S.S.R., Yugoslavia.

3/ Bangladesh, China, Fiji, India, Indonesia, Korea, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan Province of China, Thailand.

4/ Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia, Syrian AR, Turkey, United Arab Emirates, Yemen AR, Yemen PDR.

5/ Algeria, Egypt, Libya, Morocco, Tunisia.

6/ Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Congo, Cote d'Ivoire, Ethiopia, Gabon, Ghana, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Zaire, Zambia, Zimbabwe.

7/ Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela.

8/ Iran, Kuwait, Oman, Saudi Arabia, Taiwan Province of China, United Arab Emirates.

9/ Argentina, Bolivia, Brazil, Chile, Congo, Costa Rica, Cote d'Ivoire, Ecuador, Egypt, Mexico, Morocco, Nicaragua, Nigeria, Peru, Philippines, Venezuela.

10/ Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Ethiopia, Ghana, Guinea-Bissau, Guyana, Haiti, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Senegal, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia.

11/ Results from Hewitt (1991b).

Table 2. World Military Expenditure in Billion 1990 Dollars, 1985-90

	1985	1986	1987	1988	1989	1990
Total	842	948	1,007	1,007	952	941
Industrial	469	527	556	560	542	549
Eastern Europe	222	274	307	308	274	258
Developing countries	150	147	144	139	137	134
Asian developing	48	48	50	53	53	50
Middle East	66	61	58	49	48	50
North Africa	11	10	10	10	9	7
Sub-Saharan Africa	9	9	9	9	9	9
Western Hemisphere	17	19	17	18	18	19
Miscellaneous categories of developing countries:						
Net creditor nations	46	42	37	34	32	31
Heavily indebted	20	21	20	20	20	19
Small low-income	3	4	4	4	3	4

Sources: SIPRI; and staff estimates.

Table 3. World Military Expenditure Shares, 1985-90

	1985	1986	1987	1988	1989	1990	Average 1985-90
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Industrial	55.8	55.6	55.2	55.6	56.9	58.3	56.2
Eastern Europe	26.4	28.9	30.5	30.6	28.7	27.4	28.8
Developing countries	17.8	15.5	14.3	13.8	14.4	14.3	15.0
Asian developing	5.7	5.1	5.0	5.2	5.6	5.3	5.3
Middle East	7.8	6.4	5.7	4.9	5.0	5.3	5.9
North Africa	1.3	1.1	1.0	0.9	0.9	0.7	1.0
Sub-Saharan Africa	1.0	0.9	0.9	0.9	0.9	1.0	1.0
Western Hemisphere	2.1	2.0	1.7	1.8	1.9	2.0	1.9

Sources: SIPRI; and staff estimates.

Among the developing countries, military expenditures fell as a proportion of GDP from 5 percent in 1985 to 3.8 percent in 1990, continuing a downward trend that started around 1980. If military expenditures in 1990 were at the same proportion of GDP as in 1985, they would have been \$175 billion, \$40 billion higher. Middle East military expenditures were 8.1 percent of GDP in 1990, 3 percentage points of GDP lower than in 1985. Military expenditures in proportion to GDP were lowest in the Western Hemisphere developing countries (1.8 percent). The Asian developing countries (3.5 percent), North Africa (3.9 percent), and Sub-Saharan Africa (3.2 percent) had ratios of military expenditures to GDP somewhat below the world average in 1990. Net creditor developing countries (6.1 percent) spent considerably more than average, heavily indebted (1.8 percent) and small low-income economies (2.7 percent) spent considerably less.

In relation to central government expenditures, military expenditures fell from 17.8 percent of central government expenditures in 1985 to 14.5 percent in 1990, a 19 percent drop (Table 4). The ratio fell in all but the Western Hemisphere. At the same time, central government expenditures as a share of GDP decreased from 31.3 percent in 1985 to 29.6 percent in 1990 and fell in all regions except Sub-Saharan Africa (Table 5). This pattern indicates a general tendency to reduce the share of resources used by government and at the same time placing an above average burden of adjustment on the military budget.

In the Asian Developing countries, central government expenditures (CGE) fell in proportion to GDP by 15 percent to 19.5 percent in 1990 while at the same time military spending in proportion to CGE fell by 6 percent to 18 percent. Among the North African countries, CGE/GDP fell by 21 percent to 35 percent of GDP while at the same time ME/CGE fell from 13 to 11 percent. Thus in these country groups, there was a general decrease in CGE in proportion to GDP and at the same time military expenditures in proportion to CGE fell; thus military spending did not keep pace with other categories of government expenditure. In Sub-Saharan Africa, CGE/GDP increased by 23 percent, at the same time the proportion of CGE allocated to military expenditures fell by 14 percent. In contrast, among the Western Hemisphere developing countries CGE/GDP fell over 21 percent and ME/CGE rose nearly 9 percent. This is not surprising since the ratio of military spending to both CGE and GDP is the lowest in this region.

The above trends indicate that substantial military expenditure decreases occurred in almost all parts of the world from 1986 to 1990. The decrease in international trade of military goods is even more pronounced (see SIPRI Yearbook). This study attempts to examine whether or not observable economic, financial, political, and geographic characteristics can explain these observed phenomena. An analysis of the determinants of military expenditures can provide insights into the reasons for the fall in expenditures and the factors that are likely to influence future levels.

Table 4. Military Expenditure in Percent of Central Government Expenditure, 1985-90

	1985	1986	1987	1988	1989	1990	Average 1985-90
Total	17.8	17.1	16.7	16.1	15.9	14.5	16.3
Industrial	15.0	14.1	13.4	12.9	12.7	11.7	13.3
Eastern Europe	30.1	29.7	30.1	29.7	30.4	... 1/	30.0
Developing countries	17.0	16.6	16.6	15.8	16.3	16.1	16.4
Asian developing	19.1	18.6	19.5	19.0	17.9	18.0	18.7
Middle East	28.7	27.3	27.1	26.3	... 2/	... 2/	27.3
North Africa	13.2	12.3	12.0	11.5	12.0	11.2	12.0
Sub-Saharan Africa	12.7	12.6	12.2	11.9	12.0	10.9	12.1
Western Hemisphere	6.9	7.4	7.1	7.1	7.1	7.5	7.2
Miscellaneous categories of developing countries:							
Net creditor nations	29.2	26.6	25.9	28.9	28.2	24.7	27.3
Heavily indebted	7.1	7.6	7.4	7.2	7.2	7.2	7.3
Small low-income	12.9	13.1	12.5	12.3	11.7	11.9	12.4

Sources: SIPRI; and staff estimates.

1/ Yugoslavia and East Germany are missing.

2/ Central Government Expenditure statistics are not reliable for Iraq, Syria and Yemen.

Table 5. Central Government Expenditure in Percent of GDP, 1985-90

	1985	1986	1987	1988	1989	1990	Average 1985-90
Total	31.3	31.3	30.9	29.9	28.7	29.6	30.3
Industrial	29.4	29.1	28.9	28.0	27.7	...	28.6
Eastern Europe	48.6	50.1	50.2	49.5	43.8	47.6	48.3
Developing countries	29.2	29.0	27.8	26.4	24.2	23.4	26.7
Asian developing	22.8	23.2	21.2	20.1	20.4	19.4	21.2
Middle East	38.5	35.4	35.6	35.1	36.1
North Africa	43.7	43.7	38.7	40.0	37.1	34.7	39.7
Sub-Saharan Africa	24.1	27.3	29.3	29.3	28.5	29.7	28.0
Western Hemisphere	29.6	29.2	28.5	26.9	25.0	23.5	27.1
Miscellaneous categories of developing countries:							
Net creditor nations	31.6	29.3	27.7	25.3	23.5	24.6	27.0
Heavily indebted	29.5	30.8	29.9	28.5	26.2	24.5	28.2
Small low-income	23.0	22.4	23.1	23.0	23.2	22.5	22.9

Sources: SIPRI; and staff estimates.

III. The Determinants of Military Expenditures

1. The demand for military expenditures: econometric methodology

The empirical portion this study examines the determinants of military spending from 1972-90 in 125 countries. The econometric specification employed is based on a public choice model whereby the political leadership of a country is seen as choosing the overall level of government expenditures and the share to allocate to the military simultaneously. The leadership maximizes its own utility. The leadership's utility takes into account the preferences of its citizens to varying degrees, depending upon the political institutions in each country. The leadership faces an economy-wide budget constraint, a foreign financing constraint, and a revenue constraint.

The solution to this model is a simultaneous equations system, see Appendix 2 for the full derivation. In the first equation, military expenditures as a ratio of GDP (ME/GDP) is the dependent variable with the explanatory variables of central government expenditure as a ratio of GDP (CGE/GDP), GDP in US\$ (purchasing power parity prices), population (POP), the level of foreign financing (FF), geographical variables and political variables.

$$\begin{array}{ccccccc} & + & ? & ? & + & + & \\ \text{ME/GDP} & - & F[\text{CGE/GDP, GDP}\$, \text{POP, FF, geographical variables,} \\ & & +/? & & & & \\ & & \text{political variables}], & & & & \end{array} \quad (1A)$$

political variables (mutually exclusive dummy variables):

war:	international war	(+)
	civil war	(+)
non-war:	multiparty democracy	(benchmark)
	socialist government	(?)
	monarchy	(?)
	military government	(+)
	other	(?)

The expected signs follow from the rationale for the inclusion of the given variables. In general, such variables as central government expenditures and the financial variables are expected to have a positive effect on military expenditures since they increase the overall availability of resources. The impact of GDP and population is uncertain since offsetting tendencies exist. Because of the public good feature, one could expect ME/GDP could fall as GDP and population rise. However, because of the sharing the costs of the military and the fact that larger countries have the possibility of being major regional or global military powers, a positive association could exist.

The geographic variables are included as indicators of cost factors of defending a nation. The political variables are included as rough

approximations of the political institutions in different countries, see Appendix 2 and Tables 8 and 9 below for further elaboration. The benchmark category is a multiparty democracy not engaged in war. Obviously the presence of war will increase the demand for military expenditures. Furthermore it is hypothesized that a country run by a military government will place a higher emphasis on military security.

In the second equation, CGE/GDP is the dependent variable with the determining factors of ME/GDP, a development index (DI), the political variables, and the availability of external financing,

$$\text{CGE/GDP} = G[\text{ME/GDP}, \text{DI}, \text{political variables}, (1+\text{FF})/\text{GDP\$}]. \quad (1\text{B})$$

In this equation, military expenditures are expected to have a positive influence. The development index is meant to be a proxy for the ability of the government to raise revenues and therefore is expected to be positive. Availability of foreign financing is expected to have a positive influence for essentially the same reasons.

The specific equations estimated, derived by assuming a Cobb-Douglas utility function for the leadership, are as follows:

$$\begin{aligned} \ln(\text{ME}_{it}/\text{GDP}_{it}) = & \beta + \beta_1 \ln(\text{GDP\$}_{it}) + \beta_2 \ln^2(\text{GDP\$}_{it}) + \beta_3 \ln(\text{POP}_i) \\ & + \beta_4 \ln(\text{CGE}_{it}/\text{GDP}_{it}) + \beta_5 \ln(\text{CB}_i) + \beta_6 \ln(\text{LB}_i) + \beta_7 \ln(\text{LA}_i) \\ & + \beta_8 (\text{HD70}_i) + \beta_9 (\text{HD80}_i) + \beta_{10} (\text{SLIE}_i) + \beta_{11} (\text{PGFF}_{it}) \\ & + \text{political dummy variables}(i_t) + u_{it}, \end{aligned} \quad (2\text{A})$$

$$\begin{aligned} \ln(\text{CGE}_{it}/\text{GDP}_{it}) = & \gamma + \gamma_1 \ln(\text{ME}_{it}/\text{GDP}_{it}) + \gamma_2 (\text{DI}_{it}) + \gamma_3 (\text{HD70}_i) \\ & + \gamma_4 (\text{HD80}_i) + \gamma_5 (\text{SLIE}_i) + \gamma_6 (\text{PGFF}_{it}) + \\ & \text{political dummy variables}(i_t) \\ & + \text{year dummy variables}(t) + e_{it}. \end{aligned} \quad (2\text{B})$$

where: PGFF net flow of public and publicly guaranteed foreign financing,
 HD70 heavily indebted nations 1972-79 (dummy variable),
 HD80 heavily indebted nations 1980-88 (dummy variable),
 SLIE small low income economies (dummy variable),
 countries $i = 1, \dots, 125$,
 years $t = 1972, \dots, 1988$,
 CB coastal borders,
 LB land borders,
 LA land area.

The definition of each variable is available in Appendix 1 and the mean values are listed in Appendix Table 13. The various financial variables are included as proxies for the cost of foreign financing. In the first instance, the level of public and publicly guaranteed foreign financing is an indication of the level of concessional financing that a country receives. This level is likely to be highly correlated with the level of foreign grants--unfortunately the World Bank series on grant receipts begin with data for 1980. The dummy financial variables--HD70, HD80, and SLIE--are included to indicate the probable cost of commercial borrowing to the country. The high debt countries have been unable to borrow in some cases or must pay very high rates. The small low income economies generally have a poor credit rating and are subject to similar financing constraints.

Three different techniques were used to estimate the above equations. In the first instance, Table 6, the three staged least squares (3SLS) method is used without adjusting the data. This method produces results which are almost identical to those obtained in Hewitt (1992) in which two staged least squares (2SLS) was used with a slightly smaller sample. For the second set of results, Table 7, prior to running the regressions the data was transformed via a method suggested in Kelejian and Oates (1981) in order to correct for autocorrelation and heteroskedasticity. ^{1/} The procedure requires separate data adjustments to each equation. Starting with equation (2A), first an OLS equation is estimated for each country. For those countries with a Durbin-Watson statistic of less than 1.57, it is concluded that autocorrelation is present and the appropriate correction is made. Then for each country, all the variable values are divided by the standard error of the appropriate country equation in order to correct for cross country heteroskedasticity. This was necessary because significant differences in the variance of regression for each country were found. Using the Goldfeld-Quant test (see Sayrs 1989), the ratio of the average variance of regression for one half the sample to the other half has an F Distribution. The ratio is found to be 196.3, which indicates that the variances are unequal with a 99 percent degree of confidence. Finally, the 2SLS method is used to obtain coefficient estimates.

The process is then repeated for equation (2B) in which central government expenditures is the dependent variable, see Appendix 2 for further details. The third set of estimates, Table 12a and 12b, uses the transformed data in a fixed effects framework and on the mean values for each country (see Section V). In each table there are five different estimates. The first is for the entire sample; the second for industrial

^{1/} See the Kelejian and Oates (1981) Appendix "Autocorrelated Disturbance Terms in a Simultaneous-Equations Model" pages 296-299 and Kmenta (1986) pp. 616-633.

Table 6. Three Stage Least Square Estimations, 1972-90

	Full Sample		Industrial countries and Eastern Europe		Developing Countries		Sub-Saharan Africa		Asia, Latin America, Middle East and North Africa	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Dependent variable: Ratio of SIPRI military expenditure to GDP										
Constant	-4.590	-5.48	0.136	0.08	-5.810	-4.77	1.340	0.52	-4.110	-0.45
Real GDP in US\$	0.356	1.82	-0.153	-0.51	0.457	1.89	-1.070	-2.13	-0.121	-0.07
Real GDP in US\$ squared	-1.290	-1.53	1.390	1.14	-2.510	-2.13	4.360	1.74	-0.531	-0.06
Population	0.017	0.42	-0.076	-1.31	0.068	1.81	0.307	5.10	0.202	3.18
Ratio of cntr. gov. exp. to GDP	0.681	4.02	0.180	1.01	0.957	5.56	0.426	1.86	1.300	3.73
Land area (in square km)	0.803	7.12	0.345	2.32	1.240	5.66	0.974	4.63	1.030	1.17
Land borders (in kilometers)	0.121	2.67	0.393	6.93	0.093	1.53	0.340	3.50	-0.097	-0.28
Coastline (in kilometers)	0.070	2.00	0.380	8.21	0.037	0.77	-0.041	-0.62	0.100	0.74
International war	1.460	21.00	--	--	1.370	13.50	2.400	7.69	1.240	10.30
Civil war	1.180	16.10	--	--	1.080	14.20	1.450	10.00	1.100	10.10
Military government	0.679	11.90	0.656	2.27	0.633	11.80	0.849	6.39	0.658	5.06
Monarchy	1.190	17.70	--	--	1.130	14.60	0.805	4.14	1.210	4.65
Socialist government 1972-85	0.428	5.22	0.649	8.55	0.620	5.74	--	--	0.550	4.61
Socialist government 1986-90	0.347	3.96	0.574	7.20	0.361	2.54	--	--	0.253	1.41
Other forms of government	0.543	10.30	1.600	12.30	0.393	7.11	0.877	6.59	0.575	3.24
Net flow (PGFF)	0.655	0.94	6.480	2.97	-0.967	-1.44	1.470	1.78	-2.670	-2.18
High-debt countries 1972-79	-0.268	-3.32	--	--	-0.189	-2.45	-0.245	-1.71	-0.019	-0.13
High-debt countries 1980-90	-0.383	-6.61	--	--	-0.320	-5.61	-0.800	-6.91	-0.087	-1.14
Small low-income economies	-0.250	-5.24	--	--	-0.358	-6.88	-0.509	-4.02	-0.498	-1.30
R-squared		0.508		0.565		0.546		0.568		0.536
Number of observations		2274		587		1687		650		964
Elasticity with respect to GDP										
Minimum GDP		0.204		0.073		0.160		-0.534		-0.184
Maximum GDP		-0.040		0.274		-0.287		0.271		-0.278
Dependent variable: Ratio of central government expenditure to GDP										
Constant	3.320	65.40	3.430	39.60	3.100	58.60	3.250	26.00	3.080	45.20
SIPRI military expend. to GDP	-0.001	-0.03	-0.164	-3.24	0.216	6.04	0.013	0.18	0.420	9.00
Development Index	0.303	9.98	-0.535	-4.46	0.251	8.39	0.139	1.84	0.326	8.64
International war	0.236	3.16	--	--	-0.062	-0.79	0.501	1.69	-0.342	-3.72
Civil war	-0.086	-1.40	--	--	-0.292	-4.70	0.127	0.76	-0.439	-5.92
Military government	-0.146	-3.92	0.115	0.37	-0.222	-5.62	0.042	0.35	-0.311	-6.29
Monarchy	-0.009	-0.16	--	--	-0.145	-2.39	0.146	1.10	-0.383	-5.17
Socialist government 1972-85	0.391	7.37	0.246	2.19	-0.063	-0.81	--	--	-0.177	-2.04
Socialist government 1986-90	0.185	2.91	0.084	0.72	-0.016	-0.17	--	--	-0.041	-0.42
Other forms of government	-0.062	-1.72	-0.169	-1.70	-0.109	-2.83	0.205	1.62	-0.344	-7.58
Net flow (PGFF)	3.660	14.70	-1.040	-0.46	3.410	15.00	3.650	11.00	2.760	8.64
High-debt countries 1972-79	-0.194	-4.37	--	--	-0.128	-3.17	-0.210	-2.57	-0.122	-2.60
High-debt countries 1980-90	-0.147	-3.77	--	--	-0.059	-1.65	-0.102	-1.10	-0.035	-0.86
Small low-income economies	-0.004	-0.10	--	--	0.092	2.76	-0.360	-4.54	0.137	1.93
1973	0.026	0.45	0.046	0.46	0.038	0.66	0.011	0.13	0.003	0.04
1974	0.040	0.69	0.105	1.05	0.036	0.62	0.009	0.11	0.004	0.06
1975	0.116	1.99	0.188	1.87	0.094	1.64	0.123	1.50	0.019	0.30
1976	0.125	2.14	0.178	1.77	0.106	1.82	0.116	1.41	0.032	0.49
1977	0.108	1.84	0.185	1.83	0.089	1.54	0.087	1.05	0.030	0.46
1978	0.128	2.19	0.211	2.08	0.113	1.95	0.093	1.10	0.046	0.68
1979	0.117	2.01	0.223	2.20	0.102	1.76	0.061	0.72	0.043	0.64
1980	0.137	2.33	0.246	2.42	0.116	1.97	0.064	0.75	0.044	0.67
1981	0.196	3.34	0.273	2.67	0.170	2.88	0.142	1.67	0.066	0.92
1982	0.215	3.66	0.282	2.76	0.187	3.14	0.177	2.10	0.070	0.96
1983	0.212	3.60	0.289	2.82	0.184	3.09	0.166	1.97	0.065	0.89
1984	0.200	3.42	0.267	2.61	0.177	3.00	0.146	1.76	0.061	0.85
1985	0.227	3.86	0.317	3.03	0.184	3.09	0.155	1.88	0.065	0.92
1986	0.198	3.34	0.323	3.08	0.156	2.63	0.135	1.62	0.045	0.65
1987	0.206	3.48	0.319	3.04	0.167	2.81	0.175	2.13	0.042	0.61
1988	0.188	3.19	0.300	2.86	0.158	2.67	0.196	2.37	0.032	0.48
1989	0.166	2.79	0.256	2.44	0.150	2.52	0.206	2.50	0.021	0.32
1990	0.170	2.85	0.271	2.60	0.142	2.39	0.307	3.71	-0.008	-0.14
R-squared		0.261		0.069		0.404		0.392		0.465

countries, Eastern Europe and the FSU combined; the third is for developing countries; the developing countries are split between sub-Saharan Africa and other regions of the world in the final two sets of estimates.

2. Empirical results

Econometric specification are well known to have a significant impact on empirical results, Leamer (1983). In the present case, the three sets of estimates are presented in order to check the robustness of various results through different econometric specifications. The introduction of the corrections for autocorrelation and heteroskedasticity produces results that are broadly similar, but by no means identical, to the original results. Normally, the corrections will only alter the degree of significance. However, when colinearity exists among the independent variables, it is possible that the signs of the estimated coefficient can switch. The switch in sign is an indication that the results obtained in any one equation are fragile. In some cases where this occurs, the linearity is obvious. For instance, there is clearly a relationship between the two GDP variables and population. Likewise, there is colinearity among the geographic variables. It is less clear why some of the signs of the form of government variables in the central government expenditure equation switch.

In general, the results in Table 7, which uses the 2SLS on the adjusted data, are taken as the primary results for theoretical reasons. If the coefficients are significant in Table 7 and the signs are the basically the same in Table 6, the result will be deemed robust. If however, the coefficients in Table 6 have significant opposite signs, the result will be deemed unreliable. In the in-between cases, for instance when opposite but insignificant signs are found in Table 6, the result in Table 7 will be accepted with reservations. The results in Table 12 are subject to different interpretations, see below.

a. The financial and demographic determinants of military spending

The results confirm that financial variables influence the level of military expenditures across time and across countries. In the first equation, the elasticity of military expenditures with respect to central government expenditures is positive and significant, though considerably less than unity throughout. For the entire sample the elasticity is found to be 0.7; in the subsamples, the range is about 0.5 to 0.8 (Table 7). This implies that increases or decreases in the share of resources allocated to government leads to a somewhat less than proportional change in military spending. This result could be interpreted to imply some degree of resiliency. However, when central government spending rises due to an external or internal shock, such as sharp increases in interest costs experienced in the 1980s, there is no reason that this sort of increase should induce higher military spending. In fact some crowding out of military expenditures would be expected. On the other hand, if central government expenditures increase or decrease due to a general rise or fall in the level of funding, this should have a direct positive impact on military spending.

In the second equation, military spending is found to lead to higher central government expenditures in most cases. However, for the industrial and Eastern European nations the sign varies between equations. Thus, it can be concluded that in the entire sample and in developing countries, increased military spending leads to increased central government spending while in the case of the industrial and Eastern European countries, the relationship is uncertain.

Among the coefficients that show the least stability are those associated with GDP and population, not a surprise since a linear relationship obviously exists between these variables. The level of ME/GDP is clearly effected by GDP level, however, in some the relationship is convex, the coefficient on $\ln(\text{GDP})$ is negative and the coefficient on $\ln(\text{GDP})$ squared is positive. ^{1/} In others, a concave relationship is found, military spending is a superior good at low levels of GDP and then becomes an inferior good at high levels of GDP. Since different specifications give differing results, it is more likely that military spending is a normal good, remaining at an approximately constant proportion of GDP throughout. There appears to be somewhat more evidence favoring a concave relationship, see below.

Unlike in the previous study, the coefficient on population is found to be positive and significant in most of the equations in Table 7. In Table 6, the population coefficient is positive and significant in two cases and insignificant in the other three cases. The positive elasticity with respect to population provides some insight into the motivation for military expenditures. There are two competing theories as to how military expenditures might vary across countries of different size and wealth. One theory emphasizes the defensive nature of military expenditures. Since security is a pure public good, each nation might have a threshold level of military expenditures that it deems necessary to achieve a minimum level of protection. This hypothesis predicts that military expenditures would not rise with GDP beyond a certain point and would be insensitive to population size and therefore is rejected by the findings. Military spending is found to grow with population and GDP. There are two possible explanations for why larger, higher income countries spend more. First, it may be nearly impossible for the small nations to reach the threshold level. Alternatively, since a larger population enables a country to field a larger army, population will enhance a country's military potential. Larger nations could gain more from military expenditures because of the prospect of becoming a regional or global military power.

^{1/} Thus, at low levels of GDP, military spending is an inferior good, at high levels of GDP military spending is found to be a superior good.

Table 7. Two Stage Least Square Estimations, Adjusted Data, 1972-90

	Full Sample		Industrial countries and Eastern Europe		Developing Countries		Sub-Saharan Africa		Asia, Latin America Middle East and North Africa	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Dependent variable: Ratio of SIPRI military expenditure to GDP										
Constant	0.077	0.49	-1.420	-3.97	0.756	4.21	-0.016	-0.11	1.090	4.04
Real GDP in US\$	-0.552	-4.47	-0.700	-6.49	-0.590	-5.24	-1.100	-6.11	-0.575	-3.84
Real GDP in US\$ squared	2.360	5.29	2.500	4.86	2.790	5.05	4.870	4.45	2.370	3.87
Population	0.141	4.23	0.234	4.99	0.137	3.92	0.436	5.13	0.146	2.96
Ratio of cntr. gov. exp. to GDP	0.695	4.52	0.847	5.04	0.695	3.98	0.461	1.99	0.609	2.72
Land area (in square km)	-0.308	-3.29	-0.143	-1.14	0.272	1.25	-0.047	-0.16	0.927	2.32
Land borders (in kilometers)	0.256	4.92	0.318	3.08	-0.210	-2.73	0.305	2.36	-0.435	-4.27
Coastline (in kilometers)	0.447	16.30	0.545	15.70	0.203	4.01	0.054	0.66	0.581	7.34
International war	1.250	21.00	--	--	1.300	17.00	3.670	9.70	1.370	16.00
Civil war	1.100	15.70	--	--	1.130	15.30	2.120	9.24	0.771	7.24
Military government	0.646	6.90	--	--	0.597	7.34	1.860	8.66	0.687	6.94
Monarchy	0.871	6.58	--	--	0.780	6.32	--	--	1.040	7.37
Socialist government 1972-85	0.413	7.18	0.261	4.62	0.299	2.88	--	--	0.228	1.74
Socialist government 1986-90	0.245	4.08	0.289	4.61	-0.184	-1.59	--	--	-0.212	-1.52
Other forms of government	0.647	10.20	1.570	10.60	0.520	7.98	1.940	7.85	0.135	1.13
Net flow of ext. financing (PGFF)	0.493	1.04	3.060	1.18	0.878	1.73	0.827	1.29	1.810	1.99
High-debt countries 1972-79	-0.517	-4.79	--	--	-0.435	-4.16	-1.500	-9.15	-0.414	-3.48
High-debt countries 1980-90	-0.608	-7.68	--	--	-0.544	-7.09	-1.690	-14.50	-0.364	-4.17
Small low-income economies	-0.660	-11.30	--	--	-0.625	-10.70	-0.797	-5.80	-0.575	-4.55
Adjusted R-squared	0.857		0.938		0.761		0.883		0.801	
Number of observations	2032		525		1507		425		910	
Elasticity with respect to GDP										
Minimum GDP	-0.273		-0.294		-0.260		-0.501		-0.295	
Maximum GDP	0.173		0.068		0.237		0.398		0.127	
Dependent variable: Ratio of central government expenditure to GDP										
Constant	8.480	32.30	15.200	24.70	3.330	19.90	1.800	8.45	5.510	21.80
SIPRI military expend. to GDP	1.740	54.20	1.660	29.50	1.190	24.10	1.630	13.60	0.738	10.50
Development Index	1.290	12.80	2.700	9.70	-0.461	-6.95	-0.545	-4.79	-0.464	-4.88
International war	-0.492	-3.29	--	--	0.113	1.18	-1.610	-3.91	0.741	6.01
Civil war	-1.260	-5.36	--	--	-0.611	-4.84	-1.570	-7.69	-0.708	-3.13
Military government	1.020	9.44	--	--	0.574	10.20	0.392	3.34	0.876	11.30
Monarchy	-1.630	-8.14	--	--	0.403	3.03	--	--	0.547	3.20
Socialist government 1972-85	0.601	6.72	1.220	7.73	0.594	4.28	--	--	1.040	6.09
Socialist government 1986-90	-0.043	-0.42	0.219	1.36	0.867	5.26	--	--	1.190	6.27
Other forms of government	0.705	6.96	-1.900	-2.16	0.821	15.50	0.962	8.47	0.114	1.20
Net flow of ext. financing (PGFF)	4.110	4.29	12.600	1.76	3.500	7.52	0.584	0.90	4.850	7.35
High-debt countries 1972-79	-1.110	-4.05	--	--	-0.160	-1.22	-0.388	-1.71	-0.259	-1.70
High-debt countries 1980-90	-0.588	-3.02	--	--	0.249	2.67	0.567	3.40	0.284	2.48
Small low-income economies	1.110	9.40	--	--	0.017	0.26	-0.186	-1.41	-0.765	-4.25
Adjusted R-squared	0.838		0.867		0.824		0.945		0.760	
Number of observations	2015		525		1491		408		797	

The elasticity of military spending with respect to per capita income can be derived from the coefficients on GDP and population. In Table 7, the range over the entire sample is between 0.6 for low income countries to 0.9 for high income countries. Thus, the elasticity is clearly less than unity. As per capita income rises, military spending also is found to rise, but by a lower percentage.

The econometric results associated with the other financial variables is somewhat different from the previous study. The net flow of public and publicly guaranteed foreign financing (PGFF) has positive coefficients in Table 7 which are not significant, while in Table 6 some of the coefficients are negative. This implies that PGFF does not directly effect the ratio of military expenditures to GDP. However, in the central government expenditure equation, PGFF is found to be positive and significant for all equations except industrial and Eastern European countries. Thus, PGFF is still found to have an indirect positive effect on ME/GDP through increasing CGE/GDP. ^{1/}

The high debt countries are found to spend less on the military than other countries and to have cut back military spending in the 1980s relative to the 1970s. This relationship holds for the entire sample and for the subsamples. In the second equation, high debt countries definitely had lower CGE/GDP than others in the 1970s and their CGE/GDP in the 1980s was definitely higher than in the 1970s. However, since the coefficients vary in different equations, it is uncertain as to how their CGE compared to others in the 1980s. In general, it appears that because of the higher interest cost that these countries had to pay, their central government expenditures rose in the 1980s to a level that approximates other countries.

The small low income economies allocated a smaller share of GDP to the military than other countries. The results are mixed as to how their CGE/GDP stood in relationship to other countries.

In the central government expenditures equation, the development index (DI) is used as a proxy for the level of development, see Appendix 1 for the definition. For the entire sample, a positive association between DI and CGE is found. This was expected since higher development is generally associated with a greater ability to raise revenues and thus CGE tends to be higher. In the disaggregated results, this continues to apply to the industrial and Eastern European countries. However, the opposite sign emerges among the developing countries, thus, developing countries with higher development levels have lower CGE/GDP. A possible explanation for this could be reverse causality--numerous studies have found that higher CGE deters growth.

^{1/} For Sub-Saharan Africa, this relationship is insignificant in Table 7, but is statistically significant in Table 6.

b. The political and geographic variables

The profile of the effect of the political variables on military spending is almost identical to that found in Hewitt (1992). The benchmark is a democratic government not engaged in conflict. All the coefficients associated with political variables are positive and therefore represent various tendencies to spend more on the military. The most significant coefficients are associated with international war and civil war. Next, in order of importance are monarchies, other forms of government, military governments, and socialist government in 1972-1985, and socialist governments in 1986-1990. socialist governments in 1986-1990 is a variable introduced to account for the possible effects of political changes in Eastern Europe, the FSU, and elsewhere since 1985. Indeed, it appears that these countries lowered their military spending somewhat in relation to other countries during this time period, but still spent more than democracies.

The effect of form of government on CGE/GDP varies somewhat between equations. Countries involved in civil war spent less than democratic governments, monarchies spent less, and socialist governments in the period 1973-1985 spent more. In most cases the countries with socialist governments prior to 1985 had a significantly lower CGE/GDP ratio in 1986-90. The signs on countries at war, military governments, and other governments vary across specifications leaving an uncertain conclusion.

The above results suggest that the leadership of nondemocratic countries tend to have a higher preference for military expenditures than the population at large. Presumably, the policies of countries ruled by democracy reflect the more closely the preferences of the population at large, while with other regimes the policies are more likely to reflect the preferences of the leadership. Therefore, a move towards democratic rule, or possibly more open forms of government, is likely to induce lower military spending.

The geographic variables display a somewhat unexpected pattern. The maintained hypothesis is that the geographic characteristics of a country would have an effect on the cost of defending a country and therefore on military spending. In Table 7, the strongest result is that a larger coastline induces greater military spending, and this conclusion is not contradicted by the results in Table 6 or 12. The same holds for land borders, but the results are slightly weaker. The evidence on the effect of land area is uncertain.

IV. Reasons Behind the Post-1985 Fall in Military Expenditures

The preceding econometric analysis suggests a number of factors that could explain the post-1985 decrease in military expenditures. Changes in economic and financial factors that effect the affordability of military expenditures is one possible explanation. A second explanation is changes in the priority attached to military spending--brought about either by a change in government or a shift in external security factors.

1. Financial/economic factors

The econometric analysis suggests that a change in the level of financial resources available to a country could alter the level of military spending and its ratio to GDP. Among the industrial countries, an economic slowdown is evident beginning in 1988 with a drop in the growth of real GDP from 4.3 percent in 1988 to an average of 2.4 percent, Table 8. Six of the G-7 countries experienced a significant fall in their rate of growth. 1/ Eastern Europe and the FSU also experienced a great decline in rates of growth. Among the developing countries, slow growth occurred in Sub-Saharan Africa, the Middle East, and the Western Hemisphere developing countries. These regions experienced negative real per capita GDP growth during 1985-90. Growth remained fairly brisk among the Asian developing countries.

Further evidence of the impact of a slowdown in growth on military spending is suggested from comparing military expenditures during 1985-1990 to movements in purchasing power parity per capita GDP (PPP). A strong correlation is found between ME/GDP and changes in the growth of PPP. 2/

2. Political changes and security factors

A great deal of political change occurred in the later part of the 1980s. In addition to the well publicized changes in the former socialist countries, many developing countries moved towards more open political institutions. Table 9 provides a summary listing of the distribution of countries between the political variables, see Appendix 1 for a definition of each category. 3/ From 1983 to 1989, in addition to the socialist countries, eleven countries moved between political categories. While some of the changes were offsetting, a net increase in eight democracies occurred while there were seven less military governments. Furthermore, immediately after the time period covered in this study, the pace of change accelerated.

1/ The growth figures in this section are taken from the October 1992 World Economic Outlook.

2/ Among the countries that increased their military spending, a relatively high proportion also 60 percent experience a similar rise in PPP growth; in countries where the ratio of military spending to GDP remained the same, 50 percent also had a significant rise in PPP growth; while in countries that decreased their military spending in proportion to GDP, 42 percent had a significant increase in PPP.

3/ This study does not provide the list of which countries fit into each category. The purpose of the political variables is to provide empirical insight into the determinants of military spending, rather than engage in categorizing different political regimes.

Table 8. Growth of Real GDP, 1985-90
(In percent)

	1985	1986	1987	1988	1989	1990
Industrial countries	3.3	2.8	3.2	4.3	3.3	2.4
Eastern Europe	3.1	3.4	1.8	1.3	-0.2	-7.1
Former Soviet Union	1.6	3.0	2.9	5.5	2.5	-0.4
Developing Countries	4.5	3.9	4.5	3.8	3.7	3.6
Africa	4.0	2.1	0.3	3.6	3.2	1.0
Sub-Saharan Africa	3.7	3.7	1.6	2.3	2.3	0.8
Asia	6.9	6.9	8.1	8.9	5.3	5.5
Middle East and Europe	1.8	-0.8	3.3	-1.0	3.8	5.4
Western Hemisphere	3.4	4.3	2.2	0.4	1.0	-0.1

Sources: International Monetary Fund, World Economic Outlook.

From 1990 to 1992, at least 15 countries switched political categories. ^{1/} Although such changes did not have time to effect the political variables in the econometric analysis, it is quite likely that the events leading up to these changes had an influence on government expenditure policies prior to the actual change.

Table 10 is a cross-tabulation of the political variables and changes in military spending from 1985 to 1990. The first column shows the number of countries in each category that reduced their military spending in proportion to GDP by more than 10 percent, column 2 lists the number of countries that did not change military spending as a proportion of GDP by more than 10 percent, and in column 3 the number of countries that increased military spending by more than 10 percent. In order to construct a summary statistic, the "rate", column 4, is obtained by subtracting column 1 from column 3 and dividing by the total number of countries in the category.

For the entire sample, the rating is negative 35 percent, which means that considerably more countries lowered their military expenditures as a ratio of GDP than raised them. All the categories of countries have a negative rating, the categories which had the greatest change include international war, democracies, and socialist governments, and post-1990 transition countries; their ratings ranged between negative 40 to 63 percent. Security improvements are likely to account for decreased military spending by countries at war, as well as decreased military aid resulting from the cessation of the cold war. The improved security environment brought about by the end of the cold war is also the likely explanation for the decrease in military expenditures among the democratic countries. Alternatively, the decreased military expenditures in the socialist/transition economies probably represents a reaction to internal political changes. The post-1990 transition countries probably decreased military spending in reaction to internal political changes that preceded the change in regimes.

The rating for monarchies, military governments, countries engaged in civil war, and others forms of government varied between negative 14 to negative 27 percent. Thus these countries changed relatively less than average. The changes that did occur appear to reflect both internal political changes and external security improvements. Finally, countries that underwent a major political transition prior to 1990 had a rating of negative 27 percent, thus the number of countries that cut military spending was slightly below average. The reason for this relatively mixed reaction is in part that in a number of cases the change in political category

^{1/} When a political change occurs, the country is placed in another political category in the following year. This is because the budget in force during the transition year was formulated by the preceding government. Clearly events preceding political changes can alter government policy. Furthermore, it is possible for a new government to immediately institute changes in budgetary allocations.

Table 9. Summary Statistics of Political Variables

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Countries at war											
International War	7	9	9	9	9	9	9	9	9	8	8
Civil War	10	12	12	12	12	13	12	12	11	11	11
Countries not at war											
Democracy	34	33	33	33	34	35	36	37	39	40	41
Military government	32	31	31	31	30	28	28	28	28	26	24
Monarch	7	7	7	7	7	7	7	7	7	7	7
Socialist/Transition	14	14	14	14	14	14	14	14	14	14	14
Others	21	19	19	19	19	19	19	18	17	19	20

Sources: Sivard (1990), SIPRI, Europa World Yearbook.

Table 10. Interaction Between Political Variables and Military Expenditures

	1	2	3	4	5
	Change in military Spending from 1985 to 1990 1/ ----- Lower No Change Higher (By number of countries)			Rating (3-1)/(1+2+3) (In percent)	Military Expenditures 1990 (In billion \$)
Countries at War					
International War	6	1	1	-62.5	32.7
Civil War	5	4	2	-27.3	3.3
Countries not at war					
Democracy	15	16	0	-48.4	559.1
Military government	12	6	6	-25.0	15.9
Monarch	4	0	3	-14.3	20.0
Others	9	5	4	-27.8	13.9
Socialist/Transition 2/	7	6	1	-42.9	274.6
Transition countries 3/	6	2	3	-27.3	21.3
Total	53	35	17	-35.5	940.7
Memorandum items:					
Post 1990 transition countries	9	3	3	-40.0	18.6

1/ The no change designation means that the ratio of military expenditures to GDP increased or decreased by less than 10 percent.

2/ Countries that were socialist prior to 1985.

3/ Countries that changed categories from 1983-1989.

4/ Countries that introduced democratic reforms from 1990-1992 or are in the process of introducing democratic reforms.

occurred because of a deterioration in the political situation, such as the outbreak of civil war or a military overthrow of the government.

An additional security related financial factor is the level of military assistance. Clearly, both military and economic assistance from the FSU has fallen dramatically. Although no exact figures are available, the movement in arms exports, for which a large proportion are effectively aid financed, provides an indication. According to SIPRI estimates, U.S.S.R. arms exports fell from nearly \$18 billion in 1987 to \$4 billion in 1991. Furthermore, U.S. military assistance has fallen from \$ 5.8 billion in 1985 to \$ 4.8 billion in 1989.

V. Conclusion

A sizeable drop in military expenditures has occurred since 1985, the ratio of military expenditures to GDP has fallen by 23 percent. The foregoing analysis of the determinants of military expenditures provides some explanation for this observed drop. First, financial factors are found to have a significant effect on military spending. It is likely that the poor growth performance in many developing countries in the 1980s contributed to a decrease in military spending in proportion to GDP. Furthermore, the economic decline in the late 1980s among industrialized nations could have contributed to a decline in military expenditures.

The second major category influencing military expenditures is the form of government. It can be surmised that the profound political changes that the world has witnessed in numerous countries in the recent past is in part responsible for the fall in military spending. For instance, there is evidence that the political changes in the former socialist countries have induced lower spending. Furthermore, the evidence suggests that the moves towards more democratic forms of governments in developing countries is likely to have a retarding effect on military spending.

The final factor that could explain the drop in military spending is the improved security environment in the world. Although this analysis does not directly address this issue, there are indirect indications. The drop in military spending among democracies and countries at war is probably a result of a decrease in military tensions. Military assistance by the FSU fell as a result of the cessation of the cold war and internal economic problems. Additionally, the U.S. has decreased its military aid. It is likely other countries also cut back on military assistance. This study suggest that such factors would exert a strong downward effect on military spending.

Military Expenditure Data

The primary data sources for military expenditures is the Stockholm International Peace Research Institute (SIPRI), supplemented by the US Arms Control and Disarmament Agency (ACDA). The data sources for the other variables are based upon published data by the IMF, the World Bank, the United Nations, the U.S. Central Intelligence Agency, and national accounts.

The SIPRI estimates of military expenditures were chosen because they are probably the most reliable and conform to a consistent definition. For the purposes of this study, two types of modification to the SIPRI data are made. First, the U.S.S.R. and China are among the countries omitted from the SIPRI data set. ACDA estimates for Chinese military expenditures are the only known time series source. In the case of the U.S.S.R., estimates of military expenditures are based on Steinberg (1990). Steinberg's estimates are provided in local currency, his definition is comprehensive and compatible with SIPRI's definition, and the latest estimates include an adjustment to account for price differentials within the U.S.S.R. The reader is cautioned that the military expenditure figures of both the U.S.S.R. and China are not as reliable as some of the other figures. However, it seems likely that they provide a credible estimate of the trend.

The SIPRI figures represent total government outlays on the military including military pensions, military interest payments, and paramilitary expenditures; they exclude police. SIPRI follows the NATO convention of including military aid to other nations in the military expenditures of the donating country, and does not include aid receipts from other nations in the military expenditures of the recipient countries,

SIPRI military expenditures -

Ministry of Defense budget

- non-military expenditures of the defense ministry
- + military outlays of other ministries (including military pensions and interest payments)
- + military aid to other nations
- military aid receipts from other nations.

Thus, the SIPRI military expenditures represent the domestic opportunity cost of military appropriations plus military aid to allies, or the total level of resources allocated for military purposes by a country, excluding expenditures funded by aid from foreign governments.

There are a number of potential problems with the SIPRI estimates. First, SIPRI explicitly does not include aid financed military spending. Second, military expenditures are often hidden in the budgets of other ministries. Third, off-budget expenditures financed through other means are often omitted. For instance, expenditures financed through foreign loans, direct earmarked payments to the military of mineral revenues, or funds obtained through asset sales or profits of public enterprises maybe omitted. SIPRI does make some adjustments to account for these factors. For instance, in several countries direct payments to the military of revenue

from petroleum or copper sales are added to the military budget. In others, adjustments are made when high imports of military goods are detected without a corresponding change in the Ministry of Defense budget. In a few cases, an in-depth examination of the budget is carried out to reclassify expenditures. However, particularly for the small low profile countries, the budget estimate are used without modification.

The development index and form-of-government variables are constructed variables. The form-of-government variables are interdependent dummy variables constructed from descriptions in Sivard (1991), SIPRI Yearbooks, and the Europa World Yearbook. The benchmark is a multiparty democracy not engaged in internal or external conflict. In a monarchy, power is transferred through heredity. Where there is both multi-party democracy and a monarchy present, these are categorized as democracies. A military government refers to the means by which the authority gained power and the status of the ruler before taking power. A socialist government is one that does not fit into the other categories and where the self-proclaimed ideology of the leadership is consistent with socialist ideology. The category of others refers to states that do not unambiguously fit into one of the above groups, for instance, one-party states and politically unstable states. The number of countries in each category is listed in Table 9; certain countries change status over the time period under review.

The concept for the development index, DI, comes from the United Nations Development Programme (UNDP) human development index. Among the attractive features of the UNDP index is its reliance on purchasing power parity (PPP) rates instead of official exchange rates in cross-country comparisons and the use of other indicators of the quality of life. The development index used herein is constructed in the following manner. The ratio of PPP per capita GDP (1980 real prices) to \$7000 is calculated, and a weight of 0.8 is applied. Next, the ratio of life expectancy to 70 years is calculated, and a weight of 0.2 is applied. As with the UNDP index, all countries with a per capita GDP above a certain level (\$7000) are assigned a value of unity. Implicit in this formulation is that \$7000 is the level at which a country is considered developed. The same is true of the health index. An expected life span of 70 years is considered an indication of reasonable health standards. This index differs substantially from the UNDP index. The UNDP index is based upon the log of per capita GDP as a ratio to \$5000, in 1987 prices; life expectancy as a ratio of 78 years; and the literacy rate. The variables are given equal weight. Since yearly estimates of literacy rates are not widely available for individual countries, this variable could not be used in the present analysis.

A Public Choice Model of Demand for Military Expenditures

An econometric model designed to test the determinants of military expenditures in a cross-section of countries is developed in this Appendix. The model identifies the political, economic, financial, and geographical factors that are likely to influence government decisions on the level of military expenditures and provides a framework to test the relevant hypotheses. The model does not consider the interaction between military expenditures of allies and rivals. ^{1/}

The model employs a public choice framework that analyzes how the government chooses the level of resources to allocate to the military. The primary assumption is that the leadership selects policies with the goal of maximizing its own welfare, subject to national economic and political constraints. This assumption does not imply that the political leadership is necessarily selfish or uninterested in the welfare of its citizens; any consideration can enter into the welfare calculation of the leadership. To the extent that the leadership is concerned about the welfare of citizens, the welfare function will reflect this concern.

In the model, the leadership of the country has to make two very important budgetary choices: (1) the size of the budget and therefore the ratio of private versus public use of resources in the economy, and (2) the mix of government expenditures between the military and others uses. The variables that enter the welfare function of the leadership are

$$W = \Omega[U, D, S; \text{political variables}], \quad (1)$$

where

W	the welfare level of the political leadership,
Ω	the welfare function,
U	utility derived from private consumption,
D	the level of defense derived from military expenditure,
S	social welfare derived from social expenditures (approximated by nondefense government expenditures).

The welfare function places relative weights on each of the three variables that determine welfare: private consumption, defense, and social expenditures. In order to keep the model simple and facilitate concentration on allocation of resources to the military, only two types of government expenditures are considered. While the other category includes interest payments, general government expenditures, and expenditures on economic services, for purposes of expositional ease it is referred to as social expenditures. The political variables are treated as state-of-nature factors that affect the environment in which the leadership operates or indicate the ideology of the leadership. Therefore, they determine the weights of the different elements in the welfare function.

^{1/} In the initial stages a number of variables for rival and allies were included, see Hewitt (1992). However, inconsistent results were obtained and for simplicity they were omitted from subsequent computer runs.

The welfare function in its present form is not operational. A more convenient form can be obtained through transformations based on supply-cost relationships. Simple transformations will suffice for U and S since these are not the focus of the study,

$$\begin{aligned} U &= U(C) \\ S &= S(SE), \end{aligned} \quad (2)$$

where C private consumption,
SE the level of social expenditures.

A more careful consideration is warranted for defense. Defense, or the level of security, is influenced by a number of factors that affect the cost of obtaining security. It is hypothesized that the cost function for defense is

$$D = D(ME, POP, \text{geographic variables}), \quad (3)$$

where ME the level of military expenditure,
POP population,

Geographical variables:

LA land area,
LB length of land borders,
CB length of coastal borders.

Equation (3) captures the notion that the effectiveness of military expenditure in providing security benefits will vary from country to country. For instance, larger countries are likely to be more costly to defend than small islands and therefore Chile is expected to have a higher defense budget than Mauritius, all other things being equal. The effect of population size is ambiguous. A larger population could be more costly to defend; however, a large population also acts as a deterrent to external attack.

The new welfare function, W, using equations (1), (2), and (3), is

$$W = W(C, ME, SE; POP, \text{geographic variables, political variables}). \quad (1')$$

The econometric specification uses a Cobb-Douglas functional form,

$$W = A C^{\alpha_1} ME^{\alpha_2} SE^{\alpha_3}, \quad (4)$$

In this formulation the state variables, which describe political, demographic, and economic conditions, are assumed to influence the parameters of the equation: α_1 , α_2 , and α_3 ; thus they determine the relative priority placed on C, ME, and S. Each parameters is also be assumed to take on a Cobb-Douglas functional form to arrive at equations (2A) and (2B) in the text.

The income constraint in this model is fixed by a number of interrelated equations. The government budget identities are,

$$CGE = ME + SE, \quad (5A)$$

$$CGE = T + DF + FF, \quad (5B)$$

where CGE is central government expenditure, T is government revenue, DF is domestic financing, and FF is foreign financing. Since the government is seen as managing resource allocations within the economy, its budget constraint is determined by the total level of resources available to the economy,

$$CGE = GDP - C + FF. \quad (5C)$$

Finally, since tax revenue is both a choice variable and a constraint,

$$T/GDP = H(DI, \text{form of government}), \quad (5D)$$

where DI is a development index. Equation (5D) is a behavioral relationship. The level of development is hypothesized to affect the ease with which government can raise revenues; a higher level of development is generally associated with a higher tax base and greater administrative capacity to collect taxes. The form of government is also hypothesized to influence the ability to raise revenues; for instance, a socialist government may be in a better position to collect revenue than a nonsocialist government because a higher proportion of economic assets is government-owned.

Combining the above equations yields the following maximization equation for the government leadership:

$$\begin{array}{l} \text{Maximize} \quad \Gamma = W[C, ME, (CGE-ME)] + \lambda[CGE - GDP + C - FF]. \\ C, ME, CGE \end{array} \quad (6)$$

Assuming a Cobb-Douglas welfare function, equation (4), the solution is

$$ME = [\alpha_2/(\alpha_2+\alpha_3)]CGE \quad (7A)$$

$$CGE = [\alpha_1/(\alpha_1+\alpha_3)]ME + [\alpha_3/(\alpha_1+\alpha_3)](FF + GDP). \quad (7B)$$

Equation (7) is a simultaneous equations system that determines the level of central government expenditure in the economy and proportion of the budget allocated to military expenditures. In the first equation, military expenditures are a simple proportion of the government budget, based on the relative priority of defense vis-à-vis social expenditures. In the second equation, central government expenditures have two determinants. In part, a proportion of total national economic resources (GDP + FF) is allocated to CGE based on the relative priority accorded to social expenditures vis-à-vis private expenditure. The other part of the equation indicates that CGE is also a function of ME.

By dividing equations (7A) and (7B) by GDP and allowing for the state variables' effect on the parameters of the function, the following general form of the simultaneous equations is obtained,

$$\text{ME/GDP} = F\left[\overset{+}{\text{CGE/GDP}}, \overset{?}{\text{GDP\$}}, \overset{?}{\text{POP}}, \overset{?}{\text{FF}}, \overset{+}{\text{geographical variables}}, \overset{+/?}{\text{political variables}}\right], \quad (8A)$$

$$\text{CGE/GDP} = G\left[\overset{+}{\text{ME/GDP}}, \overset{+}{\text{DI}}, \overset{-/+/?}{\text{government variables}}, \overset{+}{(1+\text{FF})/\text{GDP\$}}\right], \quad (8B)$$

where

ME	military expenditures in local currency,
GDP	GDP in local currency,
GDP\$	real GDP in U.S. dollars, 1980 purchasing power parity prices,
POP	population,
CGE	central government expenditures in local currency,
FF	foreign financing (in US dollars)
DI	a development index (see below), and

form of government (mutually exclusive dummy variables, Appendix Table 3):

multiparty democracy	(benchmark)
socialist government	(+)
military government	(?)
monarchy	(?)
other	(?)

political variables (mutually exclusive dummy variables):

war:	international war	(+)
	civil war	(+)
non-war:	multiparty democracy	(benchmark)
	socialist government	(?)
	monarchy	(?)
	military government	(+)
	other	(?)

The formulation separates direct and indirect influences on the level of military expenditures. The indirect influences are transmitted through the central government budget. Among the determinants of the level of central government expenditures are military expenditures, which are expected to have a positive influence, a development index, the form of government variables, and foreign financing. For example, consider a nation that experiences an increase in its development index. Since it is now easier to raise revenues, both its central government spending and its level of military expenditures will rise, even with constant political preferences.

The direct influences on the level of military expenditures reflect the derived demand from the welfare function, which incorporates both the cost

function and income constraints. For example, consider two identical countries that differ only in the length of their land borders. The larger country will have a higher α_2 value and will have higher demand for ME. Consequently, the larger country will have higher military expenditures and higher central government expenditures, even though the priority attached to defense is identical.

The direct influence of real GDP on ME/GDP is quite complicated and interesting. Military expenditures are often viewed as a pure public good. Therefore, a country with a larger GDP will have more defense for a given proportion of GDP spent on the military due to economies of scale. This implies a negative sign. Conversely, a higher GDP represents more resources available for financing military expenditures and a lower opportunity cost, and this implies a positive sign. Since the two effects have opposite signs, the expected sign is uncertain. Similarly, the coefficient on population could be either positive or negative. A larger population can be more costly to defend, particularly if the military is involved in domestic politics. On the other hand, a large population implies an automatic deterrent.

The financing variables present an interesting specification challenge. In the mechanical delineation of the model above, the level of foreign financing enters the determination of central government expenditures in the manner described in equation (8B). However, this formulation glosses over considerations of the cost of foreign financing and the ease of obtaining foreign financing. To account for this factor, a number of variables have been incorporated into the analysis that act as proxies for the cost of foreign financing. These variables are a dummy variable for the heavily indebted middle-income nations covering 1972-79, HD70; a dummy variable for heavily indebted nations covering 1980-90, HD80; a dummy variable for small low-income economies, SLIE; and the net flow of public and publicly guaranteed foreign financing as a ratio of GDP, PGFF. In order to avoid simultaneity problems, the lagged values of PGFF are used; in addition, since the variable can take on negative as well as positive values, the log transformation could not be applied to the variable. The hypothesized effect of the three dummy variables on the level of central government expenditure is negative while the effect of PGFF is predicted to be positive. These four variables have also been incorporated into the military expenditures equation to determine whether the financing variables affect the mix of government expenditures. The hypothesis is that easier financing terms will allow governments to engage in the luxury of higher military expenditure, and therefore, HD70, HD80, and SLIE are expected to have negative signs and PGFF is expected to have a positive sign.

As indicated above, the 3SLS method was used to estimate the equations in Table 6. The 2SLS method was used in Tables 7 and 12 with data adjusted for autocorrelation and heteroskedasticity. Furthermore, one equation in Table 8 is based on the fixed effect technique and the other on country means.

The adjustment for autocorrelation and heteroskedasticity follows descriptions in Kmenta (1986) and Kelejian and Oates (1981). For each

country an OLS estimate of military expenditures is carried out with the dependent variable ME/GDP and independent variables $\ln(\text{GDP})$, $\ln(\text{GDP})^2$, PGFF, and CGE/GDP. If the Durbin-Watson statistic is below 1.57, autocorrelation is found to be present and the standard adjustment is made and the equation is re-estimated. The standard error of the equation for each country is then used to adjust for heteroskedasticity. Then a two staged least squares estimate is made with the adjusted data to derive the estimation results on the first equation. The process is then repeated to arrive at estimates for the second equation. The results produce much higher r-squares. However, since these r-squares are based on the transformed data, they are not subject to the normal interpretation.

Disaggregated Empirical Results

1. The fixed effects model and the means estimation

Alternative estimates using the fixed effect technique and the between country estimates provide a disaggregated view of the impact of the independent variables on military expenditure policies. The between estimates based on the mean values of each country, Table 12b, concentrate on the way in which country characteristics effect the average level of military expenditures between nations. The fixed effect technique, Table 12a, allows for a different constant (or intersect) for each country and therefore lumps differences between the countries into the constant. Only factors that vary within the countries will prove significant. Thus the two offer a disaggregated view of the main estimations in Table 7 where both differences between countries and within countries are examined simultaneously. When the two effects are disaggregated, many of the coefficients are found to be insignificant. This is expected because many of the independent factors vary both within countries and between countries.

The results indicate that GDP has a concave relationship which is significant in Table 12a (positive coefficient on log GDP and a negative coefficient on log GDP squared). An insignificant weak convex relationship is found in Table 12b (negative coefficient on log GDP and a positive coefficient on log GDP squared). This implies that at low levels of GDP, within individual countries, military expenditures displays the attributes of a superior good and at high levels of GDP it becomes an inferior good. However, when examining the different military expenditure policies between countries, the military expenditures appears to be a normal good.

Central government expenditures and population are found to have a positive and significant effect on military expenditures in the fixed effects model. The relationship is insignificant in the between estimates.

Among the political variables, war, civil war and other forms of governments have positive and significant coefficients in both the fixed effects and between estimations. Military governments are positive in both, but significant only in the fixed effects equation. Monarchy is positive but insignificant in both. The financial variables are insignificant in both, other than small low income economies which are found to spend less in the between estimation.

In the central government expenditure equation, military expenditures are found to induce higher spending in both. The development index is positive and significant in the fixed effects but insignificant in the between estimate. The financial variables are insignificant in both for the most part. Among the political variables, in the between estimate, international war, civil war, monarchies, and socialist governments from 1986-90 have negative and significant coefficients while socialist governments prior to 1986 have a positive and significant coefficient. In the fixed effects estimates, international war and civil war have negative and significant coefficients while the others are insignificant.

2. Country groups

The subsample estimates provide some insight into different demand relationships for military expenditures in different country groups. In general, however, the results are surprisingly similar among the different country group equations in Table 7. The second column in Table 6 and 7 provides estimates for the industrialized countries combined with the Eastern European countries (including the FSU) and the third column provides combined estimates for developing countries. For both groups, military expenditures is found to increase with population and central government expenditures.

For the industrial and Eastern European countries, the relationship with GDP appears to be concave. At low levels of GDP, ME/GDP falls as GDP rises. At higher levels of GDP, ME/GDP is positively related to GDP. Both coastline and land borders appear to have a positive effect on military spending. Socialist countries appear to have a higher ME/GDP during the entire time period, as do other forms of government. PGFF appears to have a positive and significant impact on ME/GDP. Turning to the bottom of Tables 6 and 7, central government expenditures (CGE/GDP) are found to increase with military expenditures. The effect of the development index is uncertain. Among the political variables, other forms of government are found to have lower CGE, socialist governments are found to have higher CGE during 1972-85, while the relationship is uncertain during 1986-1990. Finally, the effect of PGFF on CGE is uncertain.

Among the developing countries, the relationship between military expenditures and GDP is uncertain since the signs switch between Tables 6 and 7. The financial and political variables have coefficients that are virtually identical to those obtained in the entire sample. Among the determinants of CGE, military spending and PGFF are found to have positive effects. The configuration of the coefficients on the political variables and financial variables is similar to those in the entire sample.

The developing countries are partitioned into two groups, column four of Tables 6 and 7 provides estimates for the Sub-Saharan African countries and column five is the combined estimates for the other regions. Once again, the results are surprisingly similar. The signs and significance for population and CGE are approximately the same. For the sub-Saharan African countries, the effect of GDP is clearly convex. For countries with low levels of GDP, as GDP rises, military spending increases by a lower proportion. At higher levels of GDP, military expenditures are found to increase more rapidly than GDP. Net debtor countries, low income countries and democracies are found to spend less on the military. As for central government expenditures, higher military spending induces higher CGE. Military governments and other forms of government seem to have higher CGE, there appears to be a positive association with PGFF while small low income economies and high debt countries from 1972-1979 seem to have lower CGE. The effect of the development index is uncertain. In the equations covering Asia, Latin America, the Middle East, and North Africa, virtually identical results are obtained.

3. Individual country results

In order to carry out the transformation of the data to correct for autocorrelation and heteroskedasticity, OLS estimations for each individual country (except Angola and Lebanon for which not enough observations exist) were carried out. Only five variables were available in these equations since most of the others are dummy variables vary mostly between countries rather than within countries. For about three-fourths of the countries the r-squared exceeded 0.5, nonetheless, in most cases none of the coefficients were significant due to the relatively small number of observations for each country. To summarize the results, in 31 cases central government expenditures have a positive and significant coefficient while in 2 cases the sign is negative and significant. In 16 cases GDP has a concave relationship with military expenditures and in 4 cases the relationship is convex and significant. Finally, in 9 cases PGFF has a positive and significant coefficient while in 3 cases the sign is negative and significant. These results provide some further support for conclusions derived in the cross section analysis.

Table 11. Country Rankings and Ratios of SIPRI
Military Expenditure to GDP, 1980-90

	Rankings			Ratios	
	1980-85	1986-90	1980-90	1980-90	1989-90
Algeria	99	90	97	1.9	1.8
Angola	7	7	7	15.8	9.4
Argentina	35	51	42	4.3	2.9
Australia	74	71	78	2.6	2.3
Austria	113	111	115	1.2	1.0
Bahrain	36	26	29	5.3	5.5
Bangladesh	107	98	104	1.6	1.6
Belgium	61	63	63	3.0	2.4
Benin	94	88	92	1.9	1.7
Bolivia	44	50	51	3.8	3.3
Botswana	67	68	68	2.9	1.7
Brazil	112	107	111	1.3	1.6
Bulgaria	47	40	47	4.0	3.8
Burkina Faso	70	57	64	2.9	2.8
Burundi	66	65	66	2.9	2.5
Cameroon	98	92	96	1.9	1.5
Canada	91	84	90	2.0	2.0
Central African Rep.	89	96	94	1.9	1.6
Chad	30	27	26	5.6	4.9
Chile	15	17	16	7.5	6.0
China	18	39	25	5.8	3.7
Colombia	90	73	86	2.2	2.7
Congo	84	47	65	2.9	3.3
Costa Rica	123	122	123	0.6	0.4
Cote d'Ivoire	116	109	114	1.2	1.4
Cuba	39	29	33	5.0	5.2
Cyprus	104	114	110	1.3	1.2
Czechoslovakia	43	45	46	4.1	3.4
Denmark	82	83	84	2.3	2.1
Dominican Republic	106	113	112	1.3	0.8
Ecuador	101	94	102	1.7	1.6
Egypt	17	24	19	6.6	4.9
El Salvador	45	44	49	3.9	3.2
Ethiopia	13	9	12	10.3	14.2
Fiji	115	80	103	1.6	2.6
Finland	93	89	91	1.9	1.8
France	46	43	48	3.9	3.6
Gabon	83	41	60	3.0	3.4
German Democratic Rep.	33	23	27	5.5	5.4
Germany, Federal Rep. of	60	58	55	3.2	2.8
Ghana	122	120	122	0.7	0.6
Greece	22	22	22	6.4	5.8
Guatemala	95	103	101	1.7	1.3
Guinea-Bissau	40	78	44	4.2	...
Guyana	27	53	36	4.8	2.2
Haiti	111	104	109	1.4	1.4
Honduras	51	20	35	4.9	7.3
Hungary	75	55	69	2.8	2.4
India	68	49	56	3.1	3.0
Indonesia	53	76	62	3.0	1.8
Iran	57	86	72	2.8	1.5
Iraq	2	2	1	21.3	20.4
Ireland	102	108	105	1.5	1.3
Israel	3	11	8	14.8	8.5
Italy	87	77	85	2.2	2.2
Jamaica	110	118	116	1.1	0.8
Japan	119	115	118	1.0	1.0
Jordan	11	10	10	11.2	10.6
Kenya	59	64	61	3.0	2.4
Korea	31	34	32	5.0	4.2
Kuwait	29	13	18	6.7	8.2
Lebanon	19	79	41	4.4	1.3
Liberia	62	75	71	2.8	2.3
Libya	9	12	11	11.2	6.8
Luxembourg	117	110	117	1.1	1.1
Madagascar	77	99	88	2.1	1.2
Malawi	80	93	87	2.1	1.6
Malaysia	28	35	30	5.2	3.8
Mali	81	67	79	2.5	3.0
Mauritania	14	...	14	8.6	...
Mauritius	125	124	125	0.3	0.2
Mexico	124	123	124	0.5	0.3
Morocco	32	33	34	5.0	4.4
Mozambique	16	14	15	7.5	7.9
Myanmar	54	61	54	3.2	2.3
Nepal	114	91	108	1.5	1.8
Netherlands	65	59	59	3.1	2.8
New Zealand	96	87	93	1.9	1.9

Table 11. Country Rankings and Ratios of SIPRI
Military Expenditure to GDP, 1980-90

	Rankings			Ratios	
	1980-85	1986-90	1980-90	1980-90	1989-90
Nicaragua	12	1	6	16.2	...
Niger	121	119	121	0.7	0.8
Nigeria	88	117	106	1.5	0.8
Norway	69	52	58	3.1	3.2
Oman	1	5	2	20.2	14.3
Pakistan	20	15	17	7.1	7.1
Panama	108	72	95	1.9	2.6
Paraguay	109	112	113	1.2	1.1
Peru	24	46	31	5.1	2.1
Philippines	92	102	100	1.8	1.7
Poland	52	60	52	3.3	2.1
Portugal	58	54	53	3.3	3.2
Romania	105	106	107	1.5	1.4
Rwanda	100	95	99	1.8	1.7
Saudi Arabia	4	4	4	19.2	16.4
Senegal	72	85	81	2.5	1.9
Sierra Leone	118	121	119	0.8	0.6
Singapore	34	25	28	5.3	4.9
Somalia	56	100	77	2.6	1.2
South Africa	49	32	45	4.2	4.5
Spain	85	82	83	2.3	1.9
Sri Lanka	103	37	67	2.9	4.1
Sudan	76	69	76	2.6	2.7
Swaziland	79	101	89	2.1	1.4
Sweden	71	70	73	2.7	2.4
Switzerland	97	97	98	1.8	1.6
Syrian AR	8	8	9	14.1	12.7
Taiwan Province of China	23	28	24	5.9	4.8
Tanzania	50	31	43	4.3	4.9
Thailand	37	42	40	4.5	3.2
Togo	86	56	74	2.6	2.9
Trinidad & Tobago	78	62	75	2.6	...
Tunisia	42	30	37	4.7	4.0
Turkey	41	36	39	4.5	4.6
Uganda	63	105	82	2.4	0.7
U.S.S.R.	5	6	5	17.9	15.9
United Arab Emirates	21	19	20	6.6	5.0
United Kingdom	38	38	38	4.7	4.0
United States	26	21	23	6.1	5.7
Uruguay	64	74	70	2.8	2.4
Venezuela	73	81	80	2.5	2.1
Yemen, AR	10	18	13	9.9	6.3
Yemen, PDR	6	3	3	19.5	23.4
Yugoslavia	48	48	50	3.8	2.9
Zaire	120	116	120	0.8	0.9
Zambia	55	66	57	3.1	1.5
Zimbabwe	25	16	21	6.5	6.4

Sources: SIPRI Yearbook, IFS.

Table 12a. Fixed Effects Estimations, Adjusted Data, 1972-90

	Full Sample		Industrial countries and Eastern Europe		Developing Countries		Sub-Saharan Africa		Asia, Latin America Middle East and North Africa	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Dependent variable: Ratio of SIPRI military expenditure to GDP										
Real GDP in US\$	1.810	11.80	0.577	2.30	1.760	9.03	-1.490	-1.27	1.590	6.22
Real GDP in US\$ squared	-8.900	-14.20	-3.080	-2.83	-9.100	-11.20	9.610	1.44	-8.810	-8.67
Population	0.057	0.87	0.089	0.36	0.348	3.99	0.011	0.06	0.615	4.96
Ratio of cntr. gov. exp. to GDP	0.344	4.87	0.270	2.97	0.081	0.81	0.277	1.14	0.104	0.90
Land area (in square km)	--	--	---	---	--	--	--	--	--	--
Land borders (in kilometers)	---	---	---	---	---	---	---	---	---	---
Coastline (in kilometers)	---	---	---	---	---	---	---	---	---	---
International war	0.559	2.91	--	--	0.419	2.21	1.170	2.55	-0.019	-0.07
Civil war	0.285	3.17	--	--	0.148	1.57	0.274	0.79	0.847	3.18
Military government	0.315	4.91	--	--	0.124	2.02	0.537	1.41	0.097	1.40
Monarchy	0.398	1.58	--	--	0.111	0.45	--	--	-0.370	-1.10
Socialist government 1972-85	-0.020	-1.02	-0.103	-4.26	0.194	5.47	--	--	0.184	4.54
Other forms of government	0.340	4.46	0.744	4.98	0.153	1.83	0.296	0.83	0.114	0.98
Net flow of ext. financing (PGFF)	0.023	0.11	1.410	1.00	0.568	2.27	-0.019	-0.04	0.891	1.98
High-debt countries 1972-79	0.236	1.64	--	--	0.276	1.95	0.098	0.80	0.350	2.13
High-debt countries 1980-90	0.104	0.80	--	--	0.102	0.79	0.008	0.12	0.119	0.83
Small low-income economies	---	---	--	--	---	---	---	---	---	---
Adjusted R-squared		0.157		0.046		0.258		0.008		0.327
Number of observations		2032		525		1507		425		910
Elasticity with respect to GDP										
Minimum GDP		0.758		0.077		0.684		-0.308		0.549
Maximum GDP		-0.924		-0.369		-0.937		1.466		-1.021
Dependent variable: Ratio of central government expenditure to GDP										
SIPRI military expend. to GDP	0.743	11.30	1.040	7.62	0.897	8.40	1.640	2.99	1.390	9.43
Development Index	0.256	7.86	0.007	0.13	0.394	7.66	1.020	8.18	0.272	4.38
International war	-0.105	-1.33	--	--	-0.169	-2.01	-2.540	-2.79	-0.908	-6.15
Civil war	-0.359	-3.38	--	--	-0.388	-3.65	-1.450	-2.87	-0.738	-4.15
Military government	0.029	0.79	--	--	0.102	2.89	-0.318	-2.11	-0.156	-3.30
Monarchy	1.100	1.40	--	--	0.993	1.37	--	--	--	--
Socialist government 1972-85	0.066	1.38	-0.007	-0.11	0.455	3.18	--	--	0.599	4.03
Other forms of government	0.015	0.33	-1.470	-7.99	0.170	3.37	0.410	2.50	0.417	6.25
Net flow of ext. financing (PGFF)	-0.206	-1.24	-7.170	-5.24	0.100	0.64	-1.010	-1.30	-0.810	-3.28
High-debt countries 1972-79	-0.190	-2.14	--	--	-0.186	-2.24	-0.178	-0.96	-0.234	-2.04
High-debt countries 1980-90	0.060	0.79	--	--	0.077	1.08	0.525	2.31	-0.069	-0.67
Small low-income economies	--	--	--	--	--	--	--	--	--	--
Adjusted R-squared		0.086		0.198		0.020		0.159		0.055
Number of observations		2015		525		1491		408		797

Table 12b. Between Estimations (Means), Adjusted Data, 1972-90

	Full Sample		Industrial countries and Eastern Europe		Developing Countries		Sub-Saharan Africa		Asia, Latin America Middle East and North Africa	
	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Dependent variable: Ratio of SIPRI military expenditure to GDP										
Constant	0.076	0.12	0.490	0.20	1.100	1.51	0.185	0.34	1.860	1.36
Real GDP in US\$	-1.280	-1.11	-2.340	-1.79	-0.761	-0.75	3.180	0.77	-0.050	-0.03
Real GDP in US\$ squared	5.260	1.27	10.600	1.63	5.640	1.13	-15.800	-0.71	2.430	0.31
Population	0.256	0.94	0.048	0.11	-0.131	-0.87	-0.109	-0.24	-0.188	-0.57
Ratio of cntr. gov. exp. to GDP	1.630	1.13	3.490	1.66	1.090	0.67	-4.920	-0.93	-0.082	-0.03
Land area (in square km)	-0.253	-0.60	-0.065	-0.09	-0.532	-0.62	-0.632	-0.56	-0.547	-0.34
Land borders (in kilometers)	0.234	1.01	0.053	0.09	0.401	1.08	0.164	0.38	0.393	0.80
Coastline (in kilometers)	0.415	3.64	0.547	2.79	-0.071	-0.34	-0.386	-0.99	0.280	0.84
International war	1.510	4.02	--	--	1.040	2.79	7.380	2.13	1.140	2.68
Civil war	1.370	3.59	--	--	1.120	3.54	4.820	2.86	0.261	0.36
Military government	1.230	1.53	--	--	0.713	1.21	2.670	2.39	0.544	0.53
Monarchy	1.550	1.49	--	--	0.644	0.80	--	--	0.472	0.53
Socialist government 1972-85	-0.049	-0.07	1.070	0.92	-3.710	-2.46	--	--	-3.330	-1.69
Socialist government 1986-90	0.566	0.48	-2.910	-0.78	5.940	2.36	--	--	6.680	2.30
Other forms of government	0.912	2.22	2.390	2.36	0.460	1.71	3.680	1.79	-0.220	-0.19
Net flow of ext. financing (PGFF)	-0.994	-0.23	3.170	0.13	3.160	0.64	22.100	1.33	9.420	0.77
High-debt countries 1972-79	-7.060	-0.66	--	--	5.940	0.54	-5.700	-1.92	4.280	0.33
High-debt countries 1980-90	2.980	0.52	--	--	-3.890	-0.66	--	--	-2.930	-0.43
Small low-income economies	-0.767	-2.26	--	--	-0.246	-1.03	-2.350	-1.10	-0.227	-0.33
Adjusted R-squared	0.869		0.896		0.797		0.925		0.830	
Number of observations	2032		525		1507		425		910	
Elasticity with respect to GDP										
Minimum GDP	-0.658		0.155		1.312		1.237		0.237	
Maximum GDP	0.336		0.972		-1.503		-1.680		0.670	
Dependent variable: Ratio of central government expenditure to GDP										
Constant	7.710	7.25	14.000	4.48	3.040	4.35	1.150	0.97	5.170	4.64
SIPRI military expend. to GDP	1.990	14.20	1.910	6.27	1.100	5.48	1.780	2.82	0.757	2.44
Development Index	0.820	1.68	-1.210	-0.30	-0.448	-1.54	-0.088	-0.12	-0.242	-0.53
International war	-1.340	-2.09	--	--	0.115	0.28	-6.390	-1.41	0.684	1.24
Civil war	-2.370	-2.42	--	--	-0.827	-1.52	-2.000	-1.81	-1.460	-1.30
Military government	0.296	0.57	--	--	0.514	1.96	0.077	0.11	1.030	2.56
Monarchy	-1.940	-2.68	--	--	0.706	1.34	--	--	0.605	0.82
Socialist government 1972-85	4.800	4.62	6.740	1.86	-1.650	-0.59	--	--	0.488	0.14
Socialist government 1986-90	-11.300	-4.07	-18.500	-1.42	4.780	1.05	--	--	2.370	0.45
Other forms of government	0.228	0.52	-9.480	-0.84	0.804	3.50	0.673	0.95	-0.111	-0.24
Net flow of ext. financing (PGFF)	8.270	1.33	20.400	0.27	9.400	3.02	18.400	1.42	11.000	2.61
High-debt countries 1972-79	15.900	0.72	--	--	-4.290	-0.39	-4.000	-0.21	-6.080	-0.37
High-debt countries 1980-90	-9.970	-0.84	--	--	2.410	0.41	0.862	0.08	3.390	0.38
Small low-income economies	0.874	1.83	--	--	-0.049	-0.18	-0.027	-0.03	-0.662	-0.81
Adjusted R-squared	0.854		0.832		0.827		0.915		0.746	
Number of observations	2015		525		1491		408		797	

Table 13. Means, Maxima, and Minima, 1972-90

	Full Sample			Industrial countries and Eastern Europe			Developing Countries		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum
SIPRI military expenditure	1.07	-1.97	3.60	1.05	-0.33	2.94	1.07	-1.97	3.60
Central government expenditure	3.31	0.10	4.89	3.57	1.40	4.28	3.22	0.10	4.89
Real GDP in US\$	10.14	5.91	15.36	11.60	8.12	15.36	9.64	5.91	14.82
Population	9.18	5.52	13.92	9.61	5.85	12.58	9.03	5.52	13.92
Land area (in square km)	0.55	-0.05	1.00	0.53	-0.05	1.00	0.55	-0.05	0.92
Land borders (in kilometers)	0.64	-0.46	1.00	0.60	-0.46	0.99	0.66	-0.46	1.00
Coastline (in kilometers)	0.51	-0.46	1.14	0.59	-0.46	1.14	0.49	-0.46	1.09
International war	0.05	--	1.00	--	--	--	0.07	--	1.00
Development Index	-0.75	-1.85	--	-0.16	-1.17	--	-0.96	-1.85	--
Civil war	0.08	--	1.00	--	--	--	0.11	--	1.00
Military government	0.25	--	1.00	--	--	--	0.33	--	1.00
Monarchy	0.05	--	1.00	--	--	--	0.07	--	1.00
Socialist government 1972-85	0.07	--	1.00	0.18	--	1.00	0.03	--	1.00
Socialist government 1986-90	0.03	--	1.00	0.08	--	1.00	0.01	--	1.00
Other forms of government	0.18	--	1.00	0.04	--	1.00	0.23	--	1.00
Net flow (PGFF)	0.03	-0.07	0.54	--	--	--	0.04	-0.07	0.54
High-debt countries 1972-79	0.06	--	1.00	--	--	--	0.08	--	1.00
High-debt countries 1980-90	0.08	--	1.00	--	--	--	0.10	--	1.00
Small low-income economies	0.25	--	1.00	--	--	--	0.33	--	1.00

	Sub-Saharan Africa			Asia, Latin America, Middle East and North Africa		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
SIPRI military expenditure	0.83	-1.97	3.14	1.24	-1.73	3.60
Central government expenditure	3.21	1.65	4.29	3.23	0.10	4.59
Real GDP in US\$	8.66	6.15	11.94	10.34	5.91	14.82
Population	8.71	6.31	11.67	9.26	5.52	13.92
Land area (in square km)	0.57	0.07	0.78	0.55	-0.05	0.92
Land borders (in kilometers)	0.73	-0.46	0.92	0.60	-0.46	1.00
Coastline (in kilometers)	0.24	-0.46	0.85	0.63	-0.46	1.09
International war	--	--	--	0.12	--	1.00
Development Index	-1.36	-1.85	-0.21	-0.68	-1.72	--
Civil war	0.16	--	1.00	0.09	--	1.00
Military government	0.41	--	1.00	0.25	--	1.00
Monarchy	0.02	--	1.00	0.12	--	1.00
Socialist government 1972-85	--	--	--	0.05	--	1.00
Socialist government 1986-90	--	--	--	0.03	--	1.00
Other forms of government	0.35	--	1.00	0.14	--	1.00
Net flow (PGFF)	0.05	-0.04	0.37	0.03	-0.07	0.54
High-debt countries 1972-79	0.04	--	1.00	0.11	--	1.00
High-debt countries 1980-90	0.05	--	1.00	0.15	--	1.00
Small low-income economies	0.72	--	1.00	0.06	--	1.00

Sources: SIPRI, ACDA, Steinberg, published World Bank and IMF sources, Europa World Yearbook; staff estimates.

REFERENCES

- Europa World Year Book 1991, (London, Europa Publications Limited, 1991).
- Hewitt, Daniel, "Military Expenditure Worldwide: Determinants and Trends, 1972-1988," Journal of Public Policy, Vol 12, No. 2 (1992) pp. 105-152.
- Hewitt, Daniel, "Military Expenditure: Econometric Testing of Economic and Political Influences," International Monetary Fund Working Paper WP/91/53 (1991a).
- Hewitt, Daniel, "Military Expenditure: International Comparison of Trends," International Monetary Fund Working Paper wp/91/54 (1991b).
- International Monetary Fund, Government Finance Statistics Yearbook (Washington DC: 1992).
- _____, International Financial Statistics (Washington, DC, 1992).
- _____, World Economic Outlook, (Washington, DC. 1992)
- Kelejian, Harry and Wallace Oates, Introduction to Econometrics: Principles and Applications, 2nd edition (New York, Harper and Row, 1981).
- Kmenta, Elements of Econometrics, 2nd edition, (New York, Macmillan, 1986).
- Leamer, Edward, "Let's Take the Con Out of Econometrics," American Economic Review, Vol 73, No. 1, pp 31-43.
- Sayrs, Lois, Pooled Time Series Analysis, (Newbury Park, CA, Sage, 1989).
- Sivard, Ruth Leger, World Military and Social Expenditures, (Washington, DC: World Priorities, 1991)
- Steinberg, Dmitri, "Soviet Defense Burden: Estimating Hidden Defense Costs," Soviet Studies, Vol. 44, No. 2 (March 1992) pp. 237-263.
- Stockholm International Peace Research Institute, SIPRI Yearbook, World Armaments and Disarmament, Volumes 1980-1992 (Oxford: Oxford University Press).
- Summers, Robert, and Alan Heston, "A New Set of International Comparisons of Real Product and Prices: Estimates for 130 Countries, 1950-1985," The Review of Income and Wealth, Series 34, No. 1 (March 1988) pp. 1-26.
- UNDP, Human Development Report 1990 (Oxford: Oxford University Press, 1990).

US Arms Control and Disarmament Agency, World Military Expenditure and Arms Transfers, 1970-1990.

US Central Intelligence Agency, The World Factbook, 1990.

World Bank, World Tables, 1989-90 (Baltimore, MD: Johns Hopkins University Press, 1990).

_____, World Debt Tables, 1989-90 (Washington, DC, 1989).