Perlo-Freeman, Sam, 2002.
The demand for military expenditure in developing countries.
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The Demand for Military Expenditure in Developing Countries

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Submitted for the degree of Doctor of Philosophy, Middlesex University, August 2002, Supervised by J. Paul Dunne.

Author's declaration

1) Much of the material in Chapter 3 is included in "The Demand for Military Spending in Developing Countries", forthcoming in *International Review of Applied Economics*, Vol. 17, No. 1, January 2003. It has also been published as *Middlesex University Business School Discussion Papers in Economics No. 99, September 2001*, and presented in various forms at the *"Fifth Middlesex Conference on Economics and Security" 2001, Arms, Conflict, Security & Development, Middlesex University 2000*, and at the *2nd Lisbon International Conference on Defence Economics* 2000.

2) Much of the material in Chapter 4 is included in "The Demand for Military Spending in Developing Countries; A Dynamic Panel Data Analysis", presented at the *3rd Lisbon International Conference on Defence Economics, June 2002.*

3) Much of the material in Chapters 5 and 6 is included in "Arms Races, Military Expenditure and Democratic Transition in South America", presented at the *Sixth Middlesex Conference on Economics & Security, June 2002.*

Acknowledgements

I would like to thank:

- Prof. Paul Dunne for supervising me for this PhD, for his invaluable comments on my work, suggestions for research, and help with finding relevant literature.
- Dr. Dirk Willenbockel for acting as my second supervisor, and discussing sections of my work with me.
- The administrative staff at Middlesex University for their friendly and efficient work.
- Middlesex University for funding this PhD with a research studentship and through teaching work.
- The Stockholm International Peace Research Institute for allowing me access to their archives to construct consistent data series on military expenditure for Argentina, Brazil and Chile.
- Prof. Ron Smith for answering various queries on econometrics.
- Prof. Thomas Scheetz, with whom I discussed aspects of military politics in Argentina.
- My fellow PhD student and office-mate Aylin Soydan for letting me bounce ideas.

Abstract

The Demand for Military Expenditure in Developing Countries, submitted by Sam Perlo-Freeman for the degree of Doctor of Philosophy, Middlesex University, September 2002.

There is a growing body of literature on the determinants of military spending, mostly either starting from the premise of a dyadic arms race, or a welfare maximisation model incorporating economic, political and strategic variables. This thesis takes the latter approach, to analyse a large sample of developing countries for the period 1981-1997. Two cross-section regressions are estimated, one for the Cold War period, one for the post-Cold War, and a panel data model for the whole period. The results of this analysis suggest that military expenditure is roughly proportional to GNP, depends positively on war and the hostile neighbours' milex, and negatively on population and democracy. There is little evidence that the coefficients differ between the two cross-section regressions, but there is strong evidence of a structural break at the end of the Cold War in the panel data results. There is also evidence of regional differences in the results, which suggests that there may be different regional dynamics in the demand for military spending. To investigate further, the South American continent was chosen, and case studies conducted for Argentina, Brazil and Chile for the period 1970-2000. The main strategic influences on milex are hypothesised to be tension between Argentina and Chile and between Peru, Bolivia and Chile, the Falklands war, and Brazil's ambitions as a great power, while national income, debt and inflation are potential economic influences. Another concern is the differing circumstances of democratic transition in the three countries, especially the level of continuing military influence. This is also hypothesised to affect whether the transition led to reduced military spending. To test these hypotheses, ARDL regressions are run for each country. Argentine milex depends positively on GDP, Chilean milex, and post-Falklands rearmament, and negatively on debt and increasing inflation. Brazilian and Chilean milex seem to be independent of GDP, following an upward trend, but both are negatively affected by debt and inflation. There are no significant external influences on Brazilian milex, but some evidence that tension with Argentina affected Chilean milex. Democracy had no effect in Brazil, a clear negative effect in Chile, and a negative effect in Argentina, but only during the Menem administration. Taken overall, the results of the thesis produce a strong and consistent picture that relates the demand for military spending to overall economic resources and to the level of external and internal threat; however, in countries such as Brazil and Chile with strong continuing military influence, an 'institutionalist' understanding may also be needed, with the military seen as a rent-seeking institution.

Contents

Acronyms used in this thesis

ACDA	The U.S: Arms Control and Disarmament Agency
ADF	Augmented Dickey-Fuller
AR	Auto-Regressive
ARDL	Auto-Regressive Distributed Lag
CGE	Central Government Expenditure
DF	Dickey-Fuller
DL	Distributed Lag
FEM	Fixed Effects Model
GDP	Gross Domestic Product
GFSY	Government Financial Statistics Yearbook
GNP	Gross National Product
GPE	Great Power Enemy
HIIK	Heidleberg International Institute of Conflict Research
IIS	Institute of International Studies
IISS	International Institute for Strategic Studies
IMF	International Monetary Fund
JDW	Jane's Defence Weekly
LAN	Latin American Newsletters
LAWR	Latin American Weekly Reports
LM	Lagrange Multiplier
LR	Likelihood Ratio
NATO	North Atlantic Treaty Organisation
PE	Potential Enemies
RCM	Random Coefficients Model
REM	Random Effects Model
SIPRI	The Stockholm International Peace Research Institute
SIVAM	Sistema de Vigilancia da Amazonia
SW	Security Web
UK	United Kingdom of Great Britain and Northern Ireland
US/USA	United States of America
USSR	Union of Soviet Socialist Republics
VAR	Vector Auto-Regression

1. Introduction: the economics of the arms trade and military spending

Levels of military spending by developing countries, and especially the volume of the global arms trade, is of considerable concern to all who are interested in global peace, security and development, for a number of reasons. Firstly, that money spent on the military may divert resources from other uses, such as health, education and social welfare. Furthermore it has been estimated that at least 20% of all 3rd World debt is the result of arms purchases (Brzoska, 1983). Secondly, excessive military spending may reduce economic growth, by diverting talent and investment from potentially more productive uses. This concern has led to probably the largest single body of literature in defence economics. The controversy was sparked by the seminal paper of Emile Benoit (Benoit, 1973) which showed a positive correlation between economic growth and military expenditure as a proportion of GDP, contrary to many expectations. However, the methodology of this study has been heavily criticised (e.g. Deger & Sen, 1983), and a majority of studies appear to show the opposite result (Dunne, 1996); however, it is likely that the direction and significance of the effect of military expenditure on growth varies considerably from country to country depending on their wealth or poverty, existence of an arms industry, etc. (e.g. Frederickson & Looney, 1983, Brauer 1993).

Thirdly, there are the consequences for regional security. High military spending and arms acquisitions in one country may provoke a like response from its neighbours and rivals. Even neighbours with no particular fear of attack may come under pressure from their military establishment to match new technology for reasons of prestige and place in the world. Such pressures may lead to regional arms races. The question of whether such 'arms races' cause wars is again controversial: some studies purport to show an empirical link (Sample, 1997) but others again question this methodology. (Diehl & Crescenzi, 1998.) Kinsella (2002) provides empirical evidence that arms transfers to the third world lead to increased incidence of conflict, though he found this to be less so for US arms sales than for Russian. What is hard to deny is that high levels of militarisation and armaments can deepen and prolong conflicts that do occur. The Iran-Iraq war of 1981-88 was only able to continue for as long as it did with the continual supply of arms from the world's major producers, by licit or illicit means. (e.g. Shalom, 1990)

Finally, high levels of militarisation may have negative consequence for political freedoms within countries, where a powerful and well-armed military may be used as an instrument of repression. Blanton (1999), for example, found a positive influence of arms imports in developing countries on levels of repression.

Such concerns have rightly made the issue of military spending an important one for both academics and policy-makers, and in particular has made the global arms trade the focus of considerable popular campaigning, policy and legislative attention, and academic study. This attention is primarily devoted to the supply of armaments, especially to developing countries. However, if military expenditure and arms purchases have economic, political and strategic consequences, they equally have economic, political and strategic causes. It is, therefore, also important to understand the demand for armaments and, more generally, for military force and all the human and economic resources that requires, as measured by overall military expenditure.[1]

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[1] The choice of military expenditure, as opposed to, say, armaments, as the variable to study demand for has been criticised in that military spending, being a measure of inputs rather than outputs, is a poor proxy for military capacity (e.g. Snyder, 1977). Military spending includes items such as military pensions, which do not contribute to current military capacity. It also fails to capture the efficiency or otherwise of military expenditure, that is, whether expenditure actually leads to meaningful capabilities. Furthermore, military expenditure is a flow, whereas military capacity may be best seen as a stock. There are however pragmatic and theoretical reasons for focusing on military expenditure. At a pragmatic level, the data problems associated with arms transfers are particularly serious, even more so than for military spending. At a theoretical level, what military expenditure does measure is the amount of economic resources a country is willing to dedicate to the military. This may be in part aimed at purchasing offensive or defensive capability, with whatever degree of efficiency, but may also be in part a measure of the political and economic importance of the military and the desire of the government to bribe or reward them with good pay and advanced technology. If considered as a proportion of GDP, they measure in some degree the militarisation of society: whether that takes the form of an aggressive or interventionist external policy, or a strong military role internally. Therefore while if one's only interest is strategic interactions, one might wish to model

To this end, this thesis analyses the demand for military expenditure in developing countries, at a theoretical and empirical level. The analysis concentrates throughout on the three areas described above: economic, political and security, as the three main dimensions that may determine levels of military expenditure. This principal tool is econometric analysis: cross-section and panel data models are used in chapters 3-4 to gauge global determinants of demand, while chapters 5 and 6 use time-series analysis of individual case-studies (Argentina, Brazil and Chile) to try to understand how the idiosyncrasies of these particular countries affect the dynamics of the demand process.

Beyond the overarching purpose of modelling the demand for military spending, there are a number of specific aims of this thesis. Firstly, now that enough time has elapsed to obtain a sufficient quantity of data, this thesis will investigate whether the pattern of demand for military expenditure has changed since the end of the Cold War. This process represented a dramatic change in the global security environment, with potentially major consequences both for the level of military expenditure worldwide, and the relative importance of the different factors that determine it.

From the end of World War 2 until the fall of the Berlin Wall in 1989, the security context of most developing countries was dominated by the rivalry between the US and the USSR and their respective alliances. While not part of these formal alliance structures, many developing countries were explicitly or implicitly linked to one or other superpower, frequently depended on them for arms supplies and other military aid, and were frequently used by them as proxies in a war the superpowers dared not fight directly. Both wars between neighbours and internal conflicts between a government and a rebel movement

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instead demand for armaments or for some measure of military capability, if one is also interested in the economic and political aspects of militarisation, then overall military expenditure is the most logical measure to use. The demand for arms is discussed in Appendix 6 of this thesis.

could carry significance in this struggle, and in turn be heavily influenced by the intervention of the US and/or the USSR. The end of the Cold War gave hopes that such proxy conflicts, with their roots in the superpower rivalry, could now be solved.

Thus the end of the Cold War is widely seen as leading to a general decline in military expenditure and arms transfers worldwide. As a whole, world military expenditure and arms trade both peaked in 1987 before starting a long decline as the Cold War ended. (ACDA, 2000, SIPRI, 1996). Developing country military spending did not peak however until 1991. (ACDA, 2000). According to SIPRI (1996), the global arms trade declined from over $40bn in 1984 to just under $20bn in 1994, before rising again slightly. (These figures are SIPRI 'trend indicators', not monetary data.) As for military expenditure, according to ACDA (2000), world military spending declined from an all-time high of $1.36 trillion in 1987 to $864 billion in 1995, a decline of 34%. This was mostly due to falls in the developed world, especially the former Soviet Union and eastern Europe, However the military share of GNP in the developing world fell from a high of 5.5% in 1985 to 2.8% in 1994. (ACDA, 1998). This may be due to the general reduction in world tension following the end of the Cold War; it may also be due in part to the trend towards democratisation in many developing countries that began before the end of the Cold War.

Hopes that reductions in military spending world-wide could lead to a 'peace dividend', however, whether in the form of lower taxes or greater spending on health, education and social welfare, proved largely illusory. Global military spending bottomed out and started to rise again from 1998, and efforts to convert arms production facilities to civil use have only been fitfully successful. (e.g. Gleditsch *et al*, 1996). Moreover, the new, unipolar environment of the Post-Cold War period presented its own security challenges. With the end of the global ideological struggle between Capitalism and Communism, other rivalries, nationalistic and religious, could come to the fore. New conflicts sprang up in many parts of the world, including 'Africa's first world war' in the Democratic Republic of Congo. In addition, the international arms market was opened up, as there were no longer so many ideological barriers to countries buying arms from one producer or another. Surplus arms from the Cold War flooded into the developing world, with a massive surfeit of small arms in Africa leading to especially dire consequences. (e.g. O'Grady 1999) More recent events have led to a new desire for military spending to counter global terrorism. One senior military analyst described the events of September 11th as 'all good things for the defence industry'.[2]

As noted, there has been an overall decline in military expenditure and in the arms trade in developing countries, as elsewhere, since the end of the Cold War. There is therefore some reason to believe that the end of the Cold War affected general levels of military expenditure. But also of interest is a change in the nature of security threats faced by most countries and, therefore, potentially a change in the nature of the determinants of military spending. A commonly stated 'stylised fact' of the post-Cold War era was that traditional interstate wars were far less common, and that internal wars, fuelled by ethnic or religious hatred or simply by the opportunity to loot resources, were a far greater issue. (e.g. Kaldor 1998). Indeed, the data backs this up to a considerable extent. The Uppsala Department of Peace and Conflict Research reports that of 108 armed conflicts recorded from 1989 to 1998, only seven were between states, with another nine being civil wars with external involvement. (Wallensteen & Sollenberg, 1999).

It is, therefore, reasonable to ask if the patterns of determinants of military spending have altered, with the balance shifting away from external factors, that is regional wars, tensions and arms races, and towards internal conflict and political factors. In econometric terms, have the coefficients of the various regressors for military spending changed between the

[2] Campaign Against Arms Trade News, December 2001.

two periods being considered? This is a question to which this thesis will attempt to offer answers.

A second specific aim is to investigate interactions between the military spending levels of neighbouring countries. One of the most commonly-used models for analysing demand for military spending is that of an action-reaction 'arms race', initially proposed by Lewis Fry Richardson in his seminal work, "Arms and Insecurity". (Richardson 1960). This supposes two rival countries, where each level of military spending or arms purchases is dependant on the other's, either current or lagged. This can be both modelled theoretically and investigated empirically. An 'arms race' in this context is established by finding positive and significant coefficients of each country's military spending on the other's.

While the empirical models in this thesis take a more general approach involving a wide range of economic, political and strategic variables, the effect of neighbours' and rivals' military spending levels will be one important factor. In fact in the cross-country studies in chapters 3 and 4, we will be looking at the total level of military expenditure by neighbours, and the total military spending by rival powers as a predictor of a country's military spending. In a sense we are looking here for regional arms races, rather than simply those between two hostile powers.

The concept of an 'arms race' could, however, be meaningfully considered in more general terms. An arms race could be taken to mean a competitive pattern of military expenditure and/or arms acquisitions. This competition is not necessarily in terms of direct response to a neighbour's military spending level; It could rather be a response by one or both countries to rising levels of tension or hostile activity between the two, where such tension leads both to want to increase their own military capability regardless of the other's. This form of interaction will be considered when we look at Argentina and Chile in chapter 6.

Structure of the thesis

In Chapter 2, the empirical and theoretical literature relating to the demand for military expenditure and armaments is surveyed. The theoretical literature may essentially be divided into two categories. The first is strategic interaction models, including 'Prisoner's Dilemma'-type game theoretical analyses and Richardson's deterministic dynamic model of arms races. The second is models based in economic theory, including neo-classical utility maximisation models, and Marxist, institutionalist and Keynesian approaches. The empirical literature is likewise divided between empirical estimations of Richardsonian arms races, and more general multivariate estimations of demand, embodying the economic theory-based models.

In Chapter 3, two multivariate cross-section estimations of demand for military expenditure are carried out, one for a period during the Cold War in the 1980's, one for the period following the end of the Cold War in the 1990s. These models incorporate economic, political and security factors. The basic model is subjected to numerous tests against alternative models to derive as much information as possible as to the nature of the demand function. An attempt is made to compare the two periods empirically, to ascertain whether the structure of the demand function has changed since the end of the Cold War.

In chapter 4, a panel data model is estimated across the combined period of the two previous models, to incorporate the temporal dimension alongside the cross-section. This is broken down into regional sub-samples, as well as looking for a structural break following the end of the Cold War.

In Chapter 5, the focus shifts to South America, with case studies of the demand for military expenditure in Argentina, Brazil and Chile. The various factors that could potentially affect the demand for military spending in these countries are discussed in qualitative terms: external conflict or tension, international prestige, economic factors including growth, debt and inflation, 'new missions' such as international peacekeeping and anti-narcotics action. Particular attention is given to the question of how the presence of a military or a democratic civilian regime may influence the demand for military spending. While the general picture established across countries is that democracies spend less than totalitarian regimes, this section discusses how the picture can vary according to the relationship between the military and the civilian government following democratic transition. The very different experiences of transition in the three countries has considerable bearing on the discussion.

In Chapter 6, time-series regressions are presented for the demand for military spending for Argentina, Brazil and Chile, taking into account the insights of the previous chapter, attempting to incorporate many of the diverse economic, political and security factors discussed. Chapter 7 concludes, and Chapter 8 suggests some avenues for further research.

Chapter 2: Theoretical and empirical models of the demand for military expenditure

In this chapter we will survey the theoretical and empirical literature on the demand for military expenditure. The theoretical section will enable us to develop a broad theoretical approach from which we can proceed to develop an empirical model. The empirical section will discuss how the different theoretical approaches have been operationalised by various authors, and will look in particular at empirical models that form the basis for the one used in chapters 3 and 4 of this work.

2.1 Theoretical approaches

There are two main approaches to modelling the demand for military expenditure. One sees military expenditure decisions as coming from the dynamic strategic interaction of two or more countries, very often taking the form of an 'arms race'. This approach is particularly common in International Relations, Peace Science and other politically-oriented disciplines. The other approach sees military expenditure decisions as arising from a range of economic, political and military factors. Some of these, such as the Marxist 'under-consumptionist' approach, or the 'bureaucratic' model, treat military expenditure as purely the product of a country's internal political economy. Others, including various neo-classical models, include some measure of external threat as a factor to be considered in a utility-maximising approach.

2.1.1 Strategic approaches: Richardson's arms race model

Lewis Richardson is in many ways the father of the mathematical study of military expenditure and armaments, and his 1960 works, *Arms and Insecurity* and *The Statistics of Deadly Quarrels*, have proved seminal in the field. His model is a deterministic one, proposing two mutually antagonistic countries engaged in an arms race, each reacting to the military spending decisions of the other.

If X and Y are the military expenditures of the two countries, the Richardson model is defined by the differential equations:

$$\begin{aligned} \frac{dX}{dt} &= -\alpha_1 X + \beta_1 Y + \gamma_1 \\ \frac{dY}{dt} &= -\alpha_2 Y + \beta_2 X + \gamma_2 \end{aligned} \qquad (1)$$

With all the coefficients positive. The α coefficients are 'fatigue' terms representing the economic/political costs of maintaining high levels of military spending, the β terms are 'reaction' terms denoting the reaction to military spending by the opposing country, and the γ are 'grievance' terms, representing all other causes of military spending by the two countries.

This can be transformed into a vector differential equation:

$$\begin{pmatrix} \dot{X} \\ \dot{Y} \end{pmatrix} = \begin{pmatrix} -\alpha_1 & \beta_1 \\ \beta_2 & -\alpha_2 \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix} + \begin{pmatrix} \gamma_1 \\ \gamma_2 \end{pmatrix} \qquad (2)$$

Which can easily be solved using linear ordinary differential equations systems techniques. The result is a constant equilibrium value combined with an exponential growth/decay function. It can be shown that there is a stable long-term equilibrium if and only if the eigenvalues of the matrix in the above equation are all negative, which in turn happens if and only if $\alpha_1\alpha_2>\beta_1\beta_2$, in other words if the economic and other constraints on military spending between the two countries outweighs their mutual antagonism - otherwise there will be exponential growth in the two variables – an explosive arms race.

This model can be extended to include more than two countries without greatly complicating the mathematics (though the stability condition will become far more complicated[3]). The model can also be readily transformed into a difference equation model, giving a (perhaps more realistic) discrete model of military spending decisions rather than a continuous one. The stability conditions are unchanged.

Richardson himself used this framework to explain the arms race between the two major alliances prior to World War I, with some success.

The basic Richardson model provides a plausible account of how a rivalry between two or more countries can lead to mutual escalations in military spending. It also has the practical advantage that it is easy to operationalise and test empirically, by methods such as a co-integrating VAR, as will be discussed later. However it also carries significant limitations. Firstly it affords little or no role to economic factors, to a nation's ability to sustain a given level of military spending. (This is partially accounted for by the 'fatigue' terms in the equations, but there is no allowance for changing economic circumstances.) Secondly, it restricts its attention to the rivalry between two or possibly three powers, but gives very little role to the multiplicity of actual or perceived threats a country may face, or ambitions it may harbour, that may be a reason for military spending. The 'grievance' term encompasses all this, but is not itself modelled or allowed to vary with changing

[3] E.g. for three countries, let α_i represent country i's fatigue parameter, and let β_{ij} represent country i's reaction parameter to country j; then the system will be stable if all the real eigenvalues of the matrix $\begin{pmatrix} -\alpha_1 & \beta_{12} & \beta_{13} \\ \beta_{21} & -\alpha_2 & \beta_{23} \\ \beta_{31} & \beta_{32} & -\alpha_3 \end{pmatrix}$ are negative, which occurs if and only if

$$\alpha_1\alpha_2\alpha_3 - \alpha_1\beta_{23}\beta_{32} - \alpha_2\beta_{13}\beta_{31} - \alpha_3\beta_{12}\beta_{21} - \beta_{12}\beta_{23}\beta_{31} - \beta_{13}\beta_{32}\beta_{21} > 0.$$

circumstances. Thirdly, the deterministic dynamics of the Richardson model do not allow for a country to balance different spending priorities according to changing circumstances, but treats their reactions as given and automatic.

Such criticisms in part have led to numerous extensions, refinements and generalisations of the basic Richardson model. These can involve changes in the nature of the equations and dynamic processes, the introduction of additional strategic considerations into the equations, and/or a more rigorous treatment of economic constraints than is implied by the 'fatigue' coefficients in the Richardson equations. The result can look none too different from the more general utility maximisation models we consider later.

A very simple refinement to the dynamics of the model, adopted for example by Ward (1984), is to assume that the reaction effect relates to stocks of weapons rather than the level of military spending, which is a flow. Thus the left hand side of the equation becomes level (rather than change) in military spending, and the right hand side involves the other side's stock of weapons. A rather different dynamic approach is taken by Grossmann and Mayerkress (1989), who investigate a non-linear dynamic system for a two-country arms race. This is mathematically much more complex, in that if the system is not explosive, there are a number of different long-term outcomes where, depending on the value of a threat perception parameter, there may be a unique stable solution, a periodic solution oscillating between two or more points, or a chaotic solution, whereby the variables appear random.

Considering possible strategic refinements to the model, Intriligator & Brito (1976) marked a new departure in arms race theory in analysing the strategic implications of different mutual levels of arms, especially nuclear missiles; that is, they looked at the conditions whereby one side's stock of weapons would be sufficient to deter an attack by the other, and when one side would actually have an incentive to attack the other, as the losses caused by the other side's surviving missiles would be acceptable. This model itself led to a substantial body of literature developing it. McGuire (1965) introduces uncertainty into the picture, in that he assumes that each country can only estimate the other's military expenditure, further introducing secrecy and intelligence efforts into the model. Ward (1984), introduces perceived levels of tension between the two parties into the equation (an approach developed empirically by Oren (1994) in the case of India & Pakistan).

Moving on to economic factors, many authors incorporate a more explicit resource constraint; in the simplest form, Caspary (1967) introduces a fiscal ceiling on military spending, out of which maintenance costs of stocks of weapons must be paid. At a more complex level, Wolfson (1985), introduces an explicit trade-off between military and non-military uses of resources, thus ending up nearer the utility-maximisation models described later, though starting from a Richardsonian perspective. Other authors have introduced numerous other economic or political economy variables such as unemployment or the electoral cycle to the initial Richardson model.

Isard & Anderton (1985) provide a comprehensive survey of models developing the Richardson approach, and then themselves seek to combine many of these approaches into their own synthesised model. They suggest that the result of extending the Richardson model with such a range of economic, political and security factors to give more realistic 'fatigue' and 'grievance' functions, effectively leads to something very much like an optimisation model, such as those described later. Conversely, starting from an optimisation framework can lead, under certain conditions, to a form of Richardson model with generalised reaction, fatigue and grievance effects. They suggest that the two approaches are opposite sides of the same coin.

Ultimately however, the practical value of the Richardson model must be assessed empirically. In situations where two countries are engaged in an enduring rivalry that for both of them represents their major security threat, we may well find a basic Richardson model to be the simplest and most effective explanation for two countries' military expenditure levels. However the discussion above suggests that in most cases we must look for a more general model.

2.1.2 Strategic approaches: The Prisoner's Dilemma and related models

The Richardson approach produces a deterministic dynamic system involving continuous military expenditure variables. Another approach with a long pedigree in political theory looks at two agents (countries) with a discrete choice between two courses of action, leading to a two-by-two matrix game. These simple models have been applied to economic and strategic situations since Von Neumann & Morgenstern's "Theory of Games and Economic Behaviour" in 1944. Most widely used is the Prisoner's Dilemma game, which has been a standard model especially of the superpower arms race since the sixties. (See e.g. Brams & Kilgour (1988)).

Assume two countries X and Y engaged in a political/military rivalry. Each has the choice of High or Low military spending. ('Defecting' or 'Co-operating' in the traditional language of the Prisoner's Dilemma). There are thus four possible outcomes: (H,H), (H,L), (L,H) and (L,L) for the pair (X,Y). We assume that for X the worst outcome is (L,H) and for Y (H,L), i.e. a military disadvantage resulting. X prefers (H,L) (military advantage) to (H,H) (escalation of arms race), symmetrically for Y, and both prefer (L,L) (mutual security at low military levels) to (H,H). However the choice between (L,L) and military advantage could go either way; a country which places a high emphasis on security would prefer military advantage, while one with a high emphasis on social provision would prefer (L,L).

The classic Prisoner's Dilemma arises when both countries prefer military advantage to disarmament. The resulting pay-off matrix is then:

		Country Y	
		High milex	Low milex
Country X	H	**(2,2)**	(4,1)
	L	(1,4)	(3,3)

The entries (x,y) in each position represent the pay-off to X and Y respectively. The Nash Equilibrium (H,H) is indicated in bold type. The important point is that this, the only equilibrium, where neither player has a motive to change strategy given the other's strategy, is not Pareto-efficient, as (L,L) is better for both. But at (L,L), either side would have a motive to switch to high military spending to gain a military advantage and an increased payoff of 4. While the two countries could come to an agreement to go for (L,L), there would be a serious problem of trust, as either player would have a clear motive to break the agreement, even if they are sure the other will keep it. Thus this model has the outcome of an arms race built in as the only possible Nash Equilibrium solution.

While the Prisoner's Dilemma has been the subject of most analysis, it is perfectly plausible to suppose other sets of preference orderings. For example, if both countries prefer 'butter to guns' (given that they are not actually at a military disadvantage), and thus prefer (L,L) to (H,L) or (L,H), the payoff matrix becomes:

Country X		Country Y High milex	Low milex
	H	**(2,2)**	(3,1)
	L	(1,3)	**(4,4)**

This game is sometimes referred to as "Stag Hunt". In this situation, both (H,H) and (L,L) are Nash Equilibria. Of course it is perfectly possible that the two countries might end up stuck in the inefficient equilibrium of (H,H). However a negotiated shift to (L,L) would be more feasible; the question of trust and credibility would still arise, but at least if each side believed the other's promises, they would have no incentive to break their own. In this case it would be possible for low military spending to prevail on both sides; but if some external influence led to an increase by one or both sides, an arms race could result. Perceptions of the other side's preferences may also be relevant: Plous (1993) suggests that for much of the Cold War, each side perceived the other's preference ordering to be that of the Prisoner's Dilemma, when the actual ordering was that of Stag Hunt. This clearly leads to both sides pursuing high levels of armaments (defecting).

Lichbach (1989) discusses a number of these 2-player one-shot games, and relates them to neo-classical national utility functions, discussing what conditions would be required of utility functions to produce the different types of game.

A natural extension of the Prisoner's Dilemma, taking account of the fact that military expenditure is not a one-shot affair, but an ongoing policy issue, is the Iterated Prisoner's Dilemma (IPD), whereby the two players repeatedly play the basic PD games. Many simulations have been carried out pitting different strategies against each other in trials with large numbers of iterations. The most successful strategy seems very often to be 'Tit for Tat', whereby the player initially "co-operates" (L in the arms race game), but then follows whatever the other player does, L for L and H ("defect") for H. Of course the result depends on what strategies the other players in the simulation are using. Other conceivable strategies include Naïve (always co-operate), Cynical (always defect), Punishment (Co-operate until opponent defects, then defect for ever), Three Strikes and You're Out (Tit for Tat until 3rd defection, then defect for ever), Tit for Two Tats (Defect only after rival has defected twice; co-operate immediately if rival co-operates again.) and of course many, many more. Tit for Two Tats can outperform Tit for Tat in some scenarios, depending on the other players; but overall Tit for Tat seems to be most robust. Axelrod (1984) is a key work relating to the Iterated Prisoner's Dilemma.

Prisoner's Dilemma type models inevitably leave out a great deal of potentially important factors, especially economic ones, and are clearly a highly simplified model. In particular, they provide no explanation for the different possible preference orderings.

Like the Richardson model, 2x2 game models represent military spending decisions as the product of a dyadic rivalry. While this approach yields valuable insights, it suffers from severe limitations, as a dyadic model fails to capture the multi-faceted nature of international relations and threat perceptions. The vast majority of countries face a wide range of potential threats and calls on their military resources, rather than a single all-encompassing rivalry. The dyadic model was formulated largely with reference to the US-USSR rivalry, but may not be suitable for analysing developing countries. Furthermore, even where a strong two-country rivalry exists, the progress of this rivalry and any accompanying arms race may well provoke reactions by other regional players, which could in turn impact on the dyad. This does not merely entail minor adjustments in a dyadic model, but rather invalidates the model completely. A game theoretic dyadic approach requires that each player account for the reaction of its rival, leading to a Nash

Equilibrium. But if we instead consider a multi-agent situation, the problem of finding a set of equilibrium optimum strategies becomes too complex, whether for a professional mathematician/economist, or a government planner. A Nash Equilibrium approach is, therefore, unlikely to produce meaningful results.

The value of these models is perhaps that they provide a "simple metaphor"[4] for the strategic dilemmas facing nations in their engagements with their neighbours and rivals. The very simplicity of such models can be an advantage, as it means that they can easily fit in with more sophisticated mathematical models, where different assumptions about, say, utility functions and decision processes can give rise to different 2x2 games. A Prisoner's Dilemma type model can scarcely hope to fully encapsulate most real-world situations, but can be a valuable tool of analysis, and a complement to other methodologies.

2.1.3 Economic approaches: Neo-Classical Utility Maximisaton

The 'strategic' approaches described above share the limitation that they take a rather restricted view of the forces driving military spending, frequently taking little account of economic or political factors, and restricting threat perceptions to a dyadic rivalry, or at most perhaps a 3 or 4 country interaction. The expansion of the Richardson model to include economic and political factors tends to lead to an optimisation model in any case, so a natural alternative is to start from that perspective.

A common approach in the literature is to apply a neo-classical model, where spending decisions are the outcome of a government utility maximisation problem. This allows

[4] Smith (1995)

military expenditure to depend on a range of economic, political and strategic variables, which affect the parameters of the model. The following model is based on Smith (1995).

We assume the government is seeking to maximise a utility function of the form:

$$U=U(C, S),$$

where C is "Consumption" (or civil goods), and S is "Security". This is often seen as representing national welfare as a whole, but may equally well reflect the priorities and interests of the ruling group.

S is a function of real military spending, M, and of "threat" factors; these threat factors may represent a rivals' military expenditure, or may be more broadly defined. For example if M' is a rival's military spending, we may take

$$S = M - (\beta_0 + \beta_1 M')$$

Where β_0 and β_1 are strategic parameters, and

$$U=\alpha \mathrm{Log}\,(C-C_0) + (1-\alpha)\,\mathrm{Log}\,(S)$$

Which gives a "Stone-Geary" utility function. C_0 is a minimum level of civil expenditure, and $M^*=\beta_0+\beta_1 M'$ is a minimum level of military expenditure, namely the minimum needed to prevent an overwhelming attack by the rival nation.

The budget constraint is

$Y = P_cC + P_mM$ where Y is national income and P_c and P_m are the prices of civil and military goods respectively.

The solution is:

$$M = \frac{(1-\alpha)}{p_m}(Y - p_c C_0) + \alpha(\beta_0 + \beta_1 M')$$

A dyadic version of the model can easily be specified, where the rival's military spending M' also comes from maximizing their utility function, giving a Nash Equilibrium solution.

Thus, military expenditure depends on economic resources (Y) and threat ($\beta_0 + \beta_1 M'$). Parameters such as α represent the relative weightings given to civil goods and security, and thus can represent political factors, such as the relative priorities of the regime and/or the electorate. Ultimately almost all models of military spending, regardless of their degree of complexity, come down to these three aspects, and most econometric estimations will likewise involve some such combination.

There are many ways in which this basic model can be generalised. First of all, the threat function can be taken to include other factors such as other neighbours' or rivals' military spending, measures of levels of tension, internal conflict, incidences of international terrorism, participation in international peacekeeping missions, and so forth.

Secondly, the model can be made to be dynamic in a number of ways. Smith (1995) adjusts the model to express security as a function of stocks of military goods, subject to annual depreciation, with current military spending as a flow. The resulting equations are solved using lag operators, to produce a set of dynamic equations governing the path of military spending in each country.

Deger & Sen (1981) take a rather more sophisticated dynamic approach, specifying optimal control and differential game models for military expenditure in less-developed countries. They postulate unequal-sized military rivals, who therefore have asymmetric security and threat functions, each maximising an inter-temporal welfare function expressed in a very general form. Control theory is used to find Nash Equilibrium strategies for each country. Deger and Sen conclude (rather reassuringly) that in each case a stable equilibrium results under reasonable assumptions, so that we should not expect an arms race to spiral out of control.

An intriguing broadening of the neo-classical model is proposed by Smith, Levine & Mouzakis (1999), which specifically seeks to model the demand for armaments, taking into account the choice between importing arms and producing them domestically. As well as altering the Nash Equilibrium solution between two rivals in this model, it is used to analyse policy questions relating to arms supply. The model finds that above a certain threshold national income, countries will become arms producers. As the price of arms on the international market rises (for example due to supply restrictions), this threshold income falls, leading to more countries becoming producers. Under the authors' assumptions relating to relative costs and effectiveness of imported and domestically produced arms, this can lead to the paradoxical result of an increase in the international price of arms leading to higher levels of arms production.

The premises of this type of model have been widely challenged. Smith writes (Smith 1977, p.63) "The orthodox account of the determination of military expenditure has an implied theory of the state, based on the perception of the state as a rational, class-neutral actor, balancing opportunity costs and security benefits, in order to maximise some national interest".

An assumption of a government rationally and objectively maximising some unitary 'national' interest could certainly be regarded as naïve. Military (and other) expenditure may be determined by the interaction of a whole range of competing particular interests, such as the arms producers ('military industrial complex'), trade unions, political groupings, etc. The budget-forming process within Governments is complex, representing the resolution of conflicting claims by departments by the Treasury and the Government as a whole. There is no reason to believe *a priori* that the outcome of this will represent the maximisation of some national interest function.

The link between military expenditure and "security" as assumed by the utility function may also be questioned. Military spending, and arms procurement in particular, can be extremely inefficient (e.g. Kaldor (1982)), whence it may be hard to link a level of spending to a security output. In particular, arms producing nations tend to grant very favourable terms to their own arms manufacturers, so as to ensure autonomous production capability. (Of course this autonomous capability may itself be considered as part of the security output.)

It is also important to consider the internal role of military spending, which involves both coercion and propaganda. Clearly there are many cases in which the military is used to suppress internal dissent and maintain the power of the ruling elite in a totalitarian state. But even in a democratic state, the military plays a vital role in creating a sense of national identity and unity against an external enemy, as a counterweight to class divisions within society. Therefore rather than external threat causing military expenditure, the ruling class's need for militarism as a social control leads to the creation of real or imaginary threats. In a recent democracy, moreover, there may be a need to placate the military and ensure their on-intervention in politics by maintaining high levels of military spending.

However, while it is not unusual for neoclassical models to start from the somewhat lazy assumption of a benevolent government maximising the 'Common Good' as defined by a unitary welfare function, there is no necessity to make this assumption within the neoclassical framework. A government utility function need not reflect some assumed common good, but rather the interests of the government of the day. Of course, even a dictator must give some attention to the needs of the people, but there is no reason why a utility function cannot be viewed as incorporating also the government's need to suppress dissent, to project a powerful image, and to satisfy certain particular interest groups, including a powerful military establishment. This may lead to a more complicated mathematical model than the type described above. Grossman & Helpman (1994), for example, develop a model of trade policy that assumes two special interest groups acting to influence the government through campaign contributions and electoral pressure, maximising their particular utility functions simultaneously with the government, whose utility depends on electoral support. Thus the government's utility will have to balance the effect of policy choices on their general level of electoral support, with the particular benefits they will gain from satisfying the interest groups. Grossman & Helpman (2001) develops these ideas further to analyse the full range of methods by which different interest groups can influence government policy.

A more fundamental problem, potentially, for neoclassical models is the assumption of full rational control of military spending by the government. The activities of government departments in general may be subject to bureaucratic inertia, and spending decisions may be the result of intra-governmental bureaucratic processes that do not conform to a rational set of objectives that can be meaningfully analysed. In developing countries, moreover, there may be a lack of proper defence planning, and/or a lack of effective budgetary controls. Furthermore, not all military spending may be under the control of the government; the military may have additional sources of funding, such as the proceeds of military-run industries.

Further to this, neo-classical models fail to explain how the parameters of a model arise (such as relative weight to security and consumption, and threat perception), nor do they usually allow for such parameters to change with time and internal and international conditions. For example a conclusion of 'stability' of a model such as Deger & Sen's must surely depend on the stability of the parameters of the model, which is a very large assumption. International relations are subject to crises, shocks, nationalistic fervour, political manipulations, accidental misunderstandings and so forth which may lead to otherwise stable situations spiralling out of control.

To some extent, some of these criticisms, such as the existence of funds outside the government's control, are likely to cause problems for any model of military expenditure. For all the difficulties raised, some version of the neoclassical approach is probably the most popular theoretical model used by defence economists. However other schools of thought take a completely different starting-point:

2.1.4 Marxist theories of military expenditure

Marxist economists take a variety of approaches to the role of military expenditure in capitalist political economy. Of greatest theoretical interest for explaining military spending is the "Underconsumptionist" theory. This suggests that military expenditure fulfils a necessary economic role in Capitalism, sustaining effective demand, against the natural tendency of Capitalism to stagnate and fail to fulfil a growing productive capacity,

– known as 'realisation crises'. These occur because capitalist pressure on wages means that growth in demand is outstripped by growth in potential output, so that surplus extracted from worker's labour cannot be realised as profits. While most measures to absorb surplus and maintain demand and profits would involve increasing wages and labour power, military expenditure, being unproductive, can absorb surplus without strengthening labour. Smith (1977) discusses this approach briefly, while a lengthier exposition can be found in Mandel (1968).

The under-consumptionist approach would therefore relate military spending levels to trade cycles and levels of GDP growth, but tends to ignore security aspects of military spending. However Smith (1977) questions the empirical support for this approach; on the other hand, Cusack (1992), starting from a Marxist perspective, finds significant empirical support for a model of military spending based on domestic political-economy concerns, such as the electoral cycle and levels of unemployment. (However as this also includes variables such as war and public perception of foreign concerns, it perhaps should not be considered a purely political-economic explanation of military spending). Dunne (1990) suggests that it is mostly applicable in developed countries, where there is substantial arms production to act as a vehicle for absorbing surplus value. Excess capacity in relation to demand is not likely to be a problem in most developing countries.

2.1.5 Keynesian theories

Keynesian approaches to military spending (e.g. Pivetti, 1992) tend to relate more to the effects of military spending rather than the causes. Somewhat similar to the under-consumptionist approach (though from a very different starting point), they regard military spending as a way of maintaining effective demand, thus promoting growth and controlling unemployment. Viewed as an explanation of the demand for military spending, however, this would seem to leave a lot of gaps. As well as ignoring external factors, a Keynesian approach could not explain why military spending rather than other forms of public expenditure would be used as a tool of demand management.

2.1.6 Bureaucratic or Institutional models

Institutional and bureaucratic approaches to military expenditure see military spending as driven by economic and political interest groups, aside from any external threat. In particular, this approach focuses on the role of the 'military industrial complex' (MIC) as a driver of military spending. (E.g. Melman, 1974). Even in developing countries which do not have a domestic arms industry and therefore an MIC, the military may wield considerable institutional power, and there will in addition be a substantial bureaucracy within the government associated with the military, with arms imports and so forth. Peacock & Wiseman (1967) hypothesise a 'ratchet effect' for government expenditure generally, which argues that it is much easier to increase expenditures than to reduce them, involving cutting programmes which are the subject of long-term commitments and/or have powerful bureaucracies associated with them.

Niskanen (1971) proposes a specific hypothesis that public bureaux maximise budget size, so long as the marginal output is positive. Gonzales and Mehay (1990) develop and estimate a model based on this idea, on the basis that bureaucrats seek to maximise 'discretionary' budget revenue, that is, the maximum tax revenue that the public can be persuaded to part with for a given output, over and above that which is necessary to produce that output.

An institutionalist approach is likely to yield a quite different empirical model to a utility-maximisation approach. The dynamics of the model would be important, representing inertia, the 'ratchet' effect and so forth. A deterministic trend may be incorporated to represent the political-economic power of the MIC to extract more and more resources. On the other hand external threat variables would be less prominent. National income may also be less important, as the institutional approach sees the issue as not one of rational resource allocation, so much as the political and economic strength of different interest groups. Fine (1993) gives a critical review of institutionalist approaches.

2.1.7 Value of Neoclassical utility maximisation models

The above discussion suggests that neo-classical optimisation models of military spending must be subject to significant qualifications, and may in some cases need to be complemented by institutional considerations, and those relating to domestic political economy. Nonetheless, some form of utility maximisation approach seems in many ways the most robust and adaptable starting point for examining military expenditure decisions, though there is scope for taking into account a more complex set of actors and factors than is used in the model in section 2.1.3. Even where military spending is heavily subject to bureaucratic inertia and rent-seeking, overall economic resources must provide a constraint. Most states can likewise be expected to respond to the imminent threat of war with higher military spending, while high levels of spending are likely to prove hard to justify in the long term when security threats are minimal. The utility maximisation approach can perhaps therefore tell us that military spending will depend, in very general terms on the three groups of factors mentioned before: economic resources, threat, and political factors.

This gives a fairly flexible basis on which to attempt econometric estimations, in that a number of different variables may be used to proxy these three broad elements. We may also reasonably easily take account of dynamic factors within this framework. In many cases it is not difficult to incorporate elements from other economic approaches, for example by including trends, the unemployment rate, etc.

One should be cautious of placing too much weight on precise mathematical formulations and conclusions arising from these models. To quote Smith (1995, p.76) again:

"Given these objections it would be difficult to argue that demand functions used to explain military expenditure are more than a simple metaphor for a poorly understood process. However simple metaphors can be useful."

2.2 Empirical analysis of the determinants of military expenditure

Most of the models described in the previous section can be modelled empirically, given suitable variables to act as proxies for factors such as threat perceptions and economic resources, and suitable simplifications to the mathematical specification of the model to provide an easily estimable system.

Just as theoretical models can be divided into strategic dyadic models and those based on economic theory involving a range of economic, military and political factors, so can empirical models be categorised to mirror this. A number of econometric techniques can be used to model dyadic rivalries, especially the Richardson arms race model. Neo-classical and other economically based models may be analysed by classic linear regression for cross-country studies, by time-series methods for individual countries, by panel data method to partially combine the two, and occasionally using more complex techniques, as described below.

2.2.1 Empirical estimations of the Richardson model

If stochastic terms are added to the Richardson equations (equation (1), section 2.1.1), the deterministic dynamic model is converted into a stochastic model which may be the subject of econometric estimation. Variants on the Richardson model have been estimated in this manner by numerous authors with regard to many different hypothesised arms races. The success of this has been rather mixed.

Chadwick (1986), for example, examines various measures of military capability by Asian countries from 1971-1980. One immediate problem in this regard is the rather short time-series; 10 years is not really enough for large-sample properties of estimators to operate.

The results are highly ambiguous and specification-dependent. For example, Chadwick finds that Australian military spending depends positively on Indonesian military spending and on lagged Australian spending; but if the lagged dependant variable is omitted, then Australian military spending depends instead on Thai military spending (positively), but negatively on Vietnamese troop strength (used as a proxy for unavailable military spending data), with Indonesian military spending insignificant. But if further changes to the specification are made, the truth is revealed that Australian military spending actually depends positively on Korean arms imports (instantaneously), and Japanese, US and Indian arms imports with a one-year lag. It is hard to make sense of such disparate results.

The above is perhaps a rather extreme example of "cookbook econometrics", but illustrates that identifying which other country or countries are to be included as determining factors of a country's military spending can be quite uncertain, and that consistent results can be hard to come by.

Oren (1994) examines the India-Pakistan arms competition from a rather different perspective to the Richardson framework: he looks at the hostile activity of each party as well as military expenditures. Using 2-stage least squares, he finds that each country's military burden depends positively on the level of hostility and tension between the two, but actually finds negative coefficients on the rival's military spending. (Though in the case of India he finds both the hostility and the military spending coefficients to be insignificant). He explains this by the following argument: given the same level of hostile activity, the rival nation will appear more belligerent the lower its military capacity; on the other hand if they have a high military capability but are not using it offensively, then that in itself lowers hostility perceptions. Oren develops this model in part in an attempt to reconcile contradictory results by previous authors; he reports that "Virtually every hypothesis with regard to the sign of India and Pakistan's arms reaction coefficient receives some support". (Oren, 1994, p.190)

Anderton (1989, p.350) in a survey of arms-race models and their accompanying problems, summarises the picture rather bleakly: "The result has been an extremely large and growing literature of bigger and better differential equations employing the most sophisticated empirical techniques, which has left us rather dry in terms of knowing more about arms races than we would otherwise know".

More recent work, however, has sought to extend the Richardson paradigm by taking into account both short-term and long-term adjustments, using the statistical framework of co-integration.

Military spending time-series of most countries for which data exists exhibit a unit root, generally being integrated of order I(1). That is, 'shocks' to the time-series persist indefinitely, rather than dying away. When two variables are both integrated, a simple regression of one against the other can produce a 'spurious regression'. However a meaningful relationship between them may exist in the form of co-integration.

The Engle-Granger approach (Engle & Granger, 1987) defines two variables X and Y, both integrated of the same order, to be co-integrated if the residuals from a regression of Y on X do not have a unit root. Thus, suppose the regression of Y on X gives:

$$Y_t=\alpha+\beta X_t+\upsilon_\tau$$

Then the υ_τ time-series must be stationary, that is, shocks to the series must not be persistent. This implies that deviations from the 'equilibrium' relationship $Y_t = \alpha + \beta X_t$ do not persist, i.e. the system tends to converge towards the equilibrium. In the context of an arms race, this means that there is an equilibrium relationship between the two sides which will only be departed from temporarily; if one side is getting too much of an advantage, the other will take steps to catch up, while the country with the advantage will relax its efforts.

Once co-integration is established, we look for a pair of short-term adjustment equations:

$$\Delta Y_t = -\alpha_1 \Delta Y_{t-1} + \beta_1 \Delta X_{t-1} - \delta_1 (Y_{t-1} - \alpha - \beta X_{t-1}) + \gamma_1 + \mu_t$$
$$\Delta X_t = -\alpha_2 \Delta X_{t-1} + \beta_2 \Delta Y_{t-1} + \delta_2 (Y_{t-1} - \alpha - \beta X_{t-1}) + \gamma_2 + \nu_t$$

The α,β,γ terms are again fatigue, reaction and grievance terms, while the δ terms are speed of adjustment to the equilibrium; the term in the brackets is the disequilibrium, that is the residuals from the original regression.[5]

[5] It is possible to specify the above equations as a deterministic dynamic system, leading to a 2nd order vector difference equation. This can be converted into a 4x4 1st order vector difference equation; the matrix equation can be diagonalised in a wide range of cases, though not for all feasible values of the parameters. In

A more up-to-date approach is the Structural VAR (Vector Auto-Regression) technique described in Johansen (1988), which is both more robust than the above method, and include more than two variables, searching for all possible long-run co-integrating relationships. Thus for example, the national income of two countries engaged in an arms race could be included in a VAR, or the military spending of more than two countries could be included. However as the number of variables increases, the complexity of a VAR increases very rapidly, so there is a limit to how far this can be taken. In practice the co-integrating VAR approach has generally been applied to dyadic arms races, possibly including national income variables where appropriate. The econometrics of arms races are discussed in detail in Dunne, Nikolaidou & Smith (2000).

Dunne, Nikolaidou and Smith (1999) investigate the military spending of Turkey and Greece, and of India and Pakistan, to see if an arms race can be detected in either case. In the case of India and Pakistan, they find a fairly robust co-integrating relationship, with India's (level) military spending tending to be around twice Pakistan's. The adjustment coefficients are in the right direction, but the reaction coefficients are negative, which is somewhat counter-intuitive, suggesting that changes in military spending by one country has a negative short-term effect on the other country's military spending, but a positive long-run effect.[6]

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the case where the matrix is diagonalisable, stability (all eigenvalues <=1) will be guaranteed provided $\delta_1(1+\alpha_2-\beta_2\alpha)+\delta_2(\alpha+\alpha_1\alpha-\beta_1)>0$ and $1+\alpha_1+\alpha_2+\delta_1+\delta_2\alpha>\beta_1\beta_2$, which will be true except in what seems like rather extreme circumstances; obviously if the reaction coefficients are very high (>1) the second condition can fail; the first condition could fail if for example α and β_2 were large, and δ_1 much higher than δ_2. This would mean that the equilibrium force ratio for country one compared to country two would be very high; if the ratio were lower, country one would react quickly to achieve it; this in turn would provoke a short-term reaction from country two which would outweigh the long-term adjustment towards the equilibrium.

[6] However this would reconcile the arms race hypothesis with Oren's negative result; that while India and Pakistan may not respond positively in the short term to increases in military spending by the other (and indeed may see this as a sign of peaceful intent if not accompanied by hostile activity), they may have in view a long-term goal of preserving an appropriate ratio of capability, from which they would not want to stray too far or for too long.

In the case of Greece and Turkey, the picture is not so clear. co-integrating relationships can be found, but in some cases they have the 'wrong' sign – for example positive signs on both Greek and Turkish military spending, suggesting a long-term *negative* relationship. Other relationships, incorporating both countries' GNP, the authors describe as 'difficult to interpret'.

This is perhaps not entirely surprising. India and Pakistan are for each other the prime security issue. (Though India's security policy is also influenced strongly by China.) a stable relationship between the military spending of the two is therefore quite plausible. But Greece and Turkey have numerous other security concerns. Both are members of NATO, which could affect their military spending either up or down. Turkey has been fighting a long counter-insurgency war against its Kurdish population, and also borders countries such as the former Soviet Union, Syria and Iraq, which pose significant potential security threats. It would, therefore, perhaps be quite surprising if it was possible to find a simple, long-term relationship between Greece and Turkey's military spending which took no account of these other factors.

The Greek-Turkish arms race is also studied by Avramides (1997), though only looking at the Greek equation. He finds that Greek military spending responds positively and significantly to Turkish both in the short and the long-run. Kollias and Makrydakis (1997) find that Greek and Turkish military spending cointegrate provided that a structural break is included in 1985, when Greece embarked on a series of austerity budgets. The choice of 1985 for a structural break is found by searching over all possible years for a break, and finding the year which minimises the probability of the unit-root null in the test for co-integration.

Co-integration models are at the forefront of current econometric research, including defence and peace economics. It clearly has a role to play in analysing military expenditure demand in certain specific cases where clear dyadic rivalries can be identified.

2.2.2 Discrete choice models – probabilistic estimations

The Prisoner's Dilemma game models military spending as a discrete choice between high and low levels of spending between two rivals. Smith et al (2000) seek to estimate such a discrete choice model in the case of Greece and Turkey. They use maximum likelihood methods to first classify military spending levels in each country and each year as either high or low, and then estimate the probability of each of the four possible state combinations, given the state pertaining the previous year. They find that the 'high' and 'low' military spending states are significantly different, but are able to accept the null hypothesis that the probability of high military spending for each country in a given year is independent of the rival's state in the previous year. Thus in this framework they find no evidence of an arms race between Greece and Turkey.

2.2.3 Multivariate models

Dyadic models which represent military spending as a function entirely or primarily of a rival's military spending have limited applicability. While they may provide positive results in cases such as India and Pakistan where a very strong dyadic rivalry exists and overshadows all other security concerns for the countries in question, in other cases they may leave out a variety of important factors, economic and political, or may be completely inapplicable. If we are to develop a more general empirical picture of the demand for military expenditure, it is better to start from a broader model. A neo-classical approach, while on shaky theoretical ground especially in reference to the implied theory of the state, has the distinct advantage from an empirical point of view of being able to incorporate a disparate set of variables. The literature contains numerous models that explicitly or implicitly take this as a starting point. Other economic explanations of military expenditure such as the Marxist, Keynesian or Bureaucratic, may also be tested by adding variables such as population, unemployment or a linear trend to the model.[7]

Typically we will encounter models of the form

Military spending = M (GDP, other economic factors, threat, political factors)

Other economic factors may include for example international debt, threat may include a rival's military spending and/or war dummies, and political factors may include an index of democracy or a dummy for military rule.

In addition to differences in the variables used, models vary as to the econometric techniques used, which we discuss briefly below.

Basic neo-classical models, or sometimes simply ad-hoc models, have been used to estimate demand for a number of individual countries, generally using fairly simple time-series techniques with variables specific to the country in question. Examples are Batchelor, Dunne & Lamb (2002) for South Africa, Smith (1990) for the UK, Ward & Mintz (1987) for Israel, Matelly (1999) for the US and Kollias (2001) for Cyprus. Chapter 6 of this thesis estimates individual country demand functions for Argentina, Brazil and Chile. As these models will usually incorporate dynamic elements, including a lagged dependant variable, it is necessary to have reasonably long time series – around 30 years –

[7] Though the interpretation placed on the coefficient of these variables will be heavily theoretically laden.

for estimators to be consistent. Obtaining a consistent data series of sufficient length for some developing countries can be challenging, as described in chapter 5.

Case studies of individual countries may explain demand for military spending in those countries fairly well, but it cannot give a global picture. Of course we could in principal design models for every single country, but we might be left with a problem of 'seeing the wood for the trees', and even then, such an exercise could not explain different levels of military expenditure between countries. At the opposite end of the scale to time-series models, we may employ a cross-sectional model – generally using classical linear regression – to estimate the demand for military spending across countries. This will use data for a large sample of countries in a particular year, or averaged over a period. This is the simplest approach, and can provide a useful broad picture. But it loses information regarding changes over time. For example, while one may find that, on average, larger economies spend proportionately more on the military, it does not follow that as a country grows economically, it will increase military spending proportionately. This concern is particularly important if we are interested in the response of a country to changes in its rival's spending. It may again be the case that countries facing a powerful enemy on their borders will spend more on military spending, but it does not follow that they will respond to year-on-year changes in military spending by that enemy.

For these reasons, we may seek to use models that incorporate both cross-sectional and time series information. The simplest method is simply to pool the data for each country and each year over a certain period into a single sample, regarding each country-year pair as a separate observation. This approach is used in some of the studies described here. The problem with this method is that differences between countries will tend to swamp differences over time – for example if we are looking at the effect of population on military spending, the difference between China and Lesotho at any point in time will overwhelm the changes in population within these countries.

The essential problem with this is that it discards the information that observations are grouped by country. A number of techniques can be used to overcome this problem, and the literature on these panel data techniques is extensive. This will be discussed in greater detail in chapter 4, which presents a panel data estimation of the demand for military spending in developing countries.

There are therefore numerous econometric approaches to estimating military spending demand in this way, as well as of course many ways of operationalising the economic, political and strategic dimensions of demand discussed. We may perhaps then most easily obtain a broad picture of empirical results relating to the demand for military spending by looking at a number of cross-country models in the literature. Some are cross-sectional while others use pooled data, some use global samples and others regional, one uses a two-equation model as opposed to single equation used by the others, and one takes an institutionalist as opposed to a neo-classical view; but all are in some way attempting to incorporate a diverse range of economic, political and strategic variables.

Maizels and Nissanke (1986) achieve considerable success in estimating demand for military spending in developing countries. They carry out cross-section estimations averaging military spending data from 1978-1980 for 83 developing countries; they also break the sample down into Africa, Asia and Latin America, though the regional results produce poorer fits and fewer significant variables than the global results. The focus is on economic and security variables, the latter including some relating to systemic interactions.

They find that war[8], military government[9], Central Government Expenditure as a share of GDP, growth of foreign exchange availability[10], arms supplier concentration and a Middle East dummy all have a significant positive impact on military burden, while the ratio of foreign direct investment to capital stock has a negative impact.

The R-bar squared for this study is very good, at around .66. Some of the regional analyses are also fairly successful in terms of goodness of fit, though with fewer significant coefficients. Latin America does not produce a good fit.

This study successfully incorporates some very disparate factors: on the one hand covering economic, international political and military factors; on the other, covering national, regional and global factors. Some of the results are particularly interesting. The coefficient (positive) on growth of foreign exchange availability is very high, emphasising the importance of financing arms purchases, a major component of military spending for many developing countries. The positive effect of arms supplier concentration is interesting, in that it relates to a country's place in the international suystem: the authors explain the result in the following terms; that countries heavily dependent on one arms supplier (usually the US or USSR) tend to be those that are very much involved in the global superpower power struggle – they are regional 'proxies' for their arms suppliers. As such they are likely to be more heavily militarised. The negative coefficient on foreign direct investment is not intuitively obvious – the author's suggest that causation may actually be the other way round; that investors are reluctant to invest in unstable countries or countries facing high levels of military tension, which are likely to be highly militarised. Another possibility is that countries allied to the Soviet Union, which tend to have high military burdens, were not receptive to multinational capital.

[8] External or civil – no distinction is made

[9] Rated on a scale of the degree of violence used by a military regime to maintain power (zero = civilian government)

In econometric terms, one questionable aspect of this regression is the inclusion of ratio of CGE to GNP as an independent variable, when it is very strongly endogenous, as the dependent variable, military burden, is actually a component. Unless a 2-equation model, such as Hewitt's described below is used, this must artificially raise the goodness of fit.

While the above study uses cross-section data, Rosh (1988) uses pooled data to incorporate both cross-country and time-series information. The most innovative aspect of this model is its treatment of the threat variables: Rosh seeks to explain a country's military spending in terms of the military spending of all neighbouring countries, and others able to affect the country in question's security. Rosh calls this group the country's Security Web.

Rosh includes 63 developing countries over the period 1969-1978, carrying out a pooled data estimation, using the Parks Method to correct for serial correlation. The dependant variable is military burden, and the main independent variable is the average military burden of countries in the Security Web of the country in question.

A country's Security Web includes its neighbours, but also regional powers able to project their influence beyond their immediate borders. Thus for example Nigeria is included in the Security Web of a number of West African states, as far away as Guinea. Cuba is included in the Security Web of a number of African countries. Superpowers are only occasionally included, even if they are neighbours, as Rosh judges that for most countries they are too big to defend against, and so do not affect military spending decisions. Likewise, he excludes very small neighbours who pose no potential threat whatsoever.

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[10] Exports + overseas aid – imports – debt service

Rosh finds this construct, the degree of militarisation of the Security Web to be highly significant and positive in determining military burden. Political and economic variables are also included however. Other variables found to be significant are Democracy, "Incorporation in World Economy" (Imports + Exports per capita) and "Partnership Concentration" (proportion of trade with main trading partner), which all have negative signs. This last result is in some contrast to Maizels and Nissanke, who found that trade dependence specifically on arms had a positive effect. Rosh explains the effect of trade in terms of the idea that countries that trade heavily with their neighbours are less likely to go to war with them and therefore will require less military spending, and the trade dependence result in terms of the major trading partner being able to exercise a restraining influence.

Rosh's model is an attempt to broaden the dyadic model of military spending we see in arms race models such as Richardson's. It allows for security threats coming from a variety of sources, which is arguably more realistic. It is Rosh's Security Web concept that will form the basis of the models estimated in chapters 3 & 4.

Possible weaknesses in this model include the fact that it uses a pooled data model which, as discussed, will tend to lead to differences between countries overwhelming differences over time; that it does not include variables relating to actual states of conflict; and that it treats the Security Web as homogenous, not distinguishing between allies, enemies and neutral powers (though Rosh seeks to justify this last point.) The specification of the Security Web model will be discussed in much greater detail in the next chapter.

Both of the above models are essentially based on a neo-classical utility maximisation approach. Gonzales & Mahey (1990) use a model that is in some ways related to Rosh, but with a very different theoretical framework; namely, they are attempting to assess the status of military spending as a pure public good or otherwise through the population elasticity of demand. They perform a cross-section estimation for a sample of 74 developed and developing nations, looking at military spending only in the year 1982, but relating it to the 5-year average of past allies and rivals military spending, as well as per capita income, population, democracy and certain other factors.

The authors assume that decision-makers, rather than seeking to maximise a national welfare function, are seeking to maximise discretionary budgetary revenue, that is revenue over and above the minimum necessary to produce a given level of output – in this case defence output. It is assumed that the Government can make an 'all or nothing offer' to the public – i.e. so much output for so much tax. The public cannot choose a certain level of output and then negotiate price.

In other words, the Government will tax as much as it feels able to get away with, given the service it is producing. How much can it get away with? The key factor Gonzalez and Mahey model is the effect of increasing population, given a fixed GDP per capita.

Now the amount of defence output the public will see as worthwhile will depend on conventional security factors such as allies' and rivals' military expenditure, as well as of course on income. The question analysed is one of scale, as population increases.

The first consideration is economies/diseconomies of scale in production. If there are economies of scale, then increasing population will tend to lead to increased spending, as this leads to greater benefits both for the public and for the Defence Department, who are left with more discretionary budget. If there are diseconomies of scale, then the opposite effect will apply.

The second consideration is "public-ness": Defence is generally regarded as a pure public good, i.e. one pound spent on defence is worth one pound to everyone. Thus (accepting the dubious assumption that nuclear weapons provide a security benefit), if a country has a nuclear weapon, this gives the same benefit to each citizen whether there are 100,000 people or a billion – whereas health spending, while it may be publicly available has to be divided between the population, whereas the benefit of 'nuclear deterrence' does not. Thus there is a large public-ness economy of scale in defence, so that an increase in population should tend to lead to an increase in defence spending per capita (and thus a more than proportionate increase in overall spending), as the security value of the per capita tax people are expected to pay will seem increasingly cheap at the price.

However this view of defence as a pure public good can be questioned. For example a large population may need more defending (especially if it goes with a large land area or land borders). Thus one could argue that the security benefit of money spent on military manpower does need to be divided up between all those defended. The extreme assumption is that defence is a purely private good; in other words the value any individual gains from defence spending depends on spending per capita rather than the absolute level. In this case there will be no positive scale effects form this source from increasing population. Of course, the situation may lie between these two extremes.

In combining these two effects, the result is that if defence is a purely public good, we expect a population elasticity of demand greater than unity (given fixed per capita GDP), regardless of the cost effects. If defence is a purely private good, then the population elasticity is entirely dependent on the cost economies or diseconomies of scale. (So elasticity = unity for constant costs). If defence is a partly private, partly public good, then there will be a population elasticity greater than unity unless the public-ness effect is outweighed by cost diseconomies of scale.

Gonzales & Mahey find that population has a coefficient significantly less than one both for the whole sample and for less-developed nations, but significantly greater than one for developed. The coefficient on GDP per capita is not significantly different from one either for the whole or for the sub-samples. Rivals' military spending is significant and positive. Allies military spending is also significant and positive both for the whole sample and for less-developed nations (though only at the 10% level in the latter), but negative (10%) for developed nations. If there is a formal alliance, then the effect of allies military spending becomes negative, at least for the whole sample. (The effect is undetectable for either subsample). Arms exports/GNP is positive and significant at the 10% level for the whole sample.

The results are useful and in line with general theoretical predictions, though the use of only one year's data may be a weakness. However one might argue that an awfully heavy weight of theory is resting on one statistic, the population elasticity; first of all the bureaucracy model itself is presupposed (with perhaps a rather extreme assumption of maximised inefficiency), and secondly the publicness/privateness theory is expected to be tested by the population coefficient. Thus, we cannot tell whether it is the bureaucracy model that is being tested, or the public-private good question.

It is surely possible to come up with other explanations of the result obtained. For example, the less-than-unity coefficient for developing countries and overall could be due to countries with large populations being able to reply on high levels of military manpower rather than expensive high-tech weaponry. Looking at the developed countries (where the coefficient is greater than 1), this may be due to the desire for superpower status of the US and USSR (though this sort of relates to the public/private question, as superpower status would seem to be very clearly a public 'good'). (More will be said on this in the following chapter).

All three of the above models use a fairly simple econometric methodology, involving a single equation. Hewitt (1991) develops this approach by presenting a 2-equation public choice cross-country model of military expenditure. The model aims to simultaneously determine Central Government Expenditure (CGE) and Military spending as shares of GDP. Military spending is a component of CGE, which is also affected by economic conditions (such as indebtedness, level of development which affects the ability to collect tax revenue and availability of capital) and type of Government. Military spending is in turn heavily affected by the overall level of CGE (which acts as a budget constraint), as well as by a similar set of economic and political factors. In addition, Hewitt includes GDP level and GDP squared, dummies for civil and international war, population, land area, length of borders and coastline in the equation for military spending. He does not include any effects for neighbours' military expenditure etc. Thus his model is particularly focused on economic factors.

Hewitt uses a 2-stage least squares pooled data estimation with time dummies for 125 developing countries over the period 1972-88.[11] The equations are all in log form.

In the equation for Military spending/GDP, Hewitt finds he ratio of CGE to GDP to be highly significant, with a coefficient of 0.76. Thus with fixed GDP, military spending will grow at a slower rate than CGE. There is a quadratic relationship with GDP, with a positive coefficient on log GDP, but a negative coefficient on $(\log \text{GDP})^2$, both significant. Net flow of public and publicly guaranteed external capital is positive with a

[11] He does not use standard panel data methods such as Fixed Effects as he is interested in cross-country comparisons. (Of course this means the model is subject to serious specification problems, and invalid assumptions of homogeneity, homoskedasticity, non-autocorrelation etc.)

coefficient very near to 1; Countries classified as highly indebted (especially in the 1980s) and as Small Low Income Economies spend significantly less on military spending.

Moving on to political variables, monarchies are found to spend most on the military, followed by military dictatorships, socialist governments and "other" non-democracies (e.g. one-party states, very unstable democracies); all spend significantly more than western-style democracies. Internal and external war are significant and positive. Looking at geographical variables, population is insignificant, while land area, land boundaries and coastline are all significant and positive. Dummies are included for each year, but these are all insignificant. The R^2 is about 0.56.

There are also indirect effects resulting from the CGE equation. Military burden of course has a positive effect on CGE/GDP; the development index is significant and positive, as is capital availability (adding to the direct effect). Heavily indebted nations have lower CGE, but this is only significant for the 70's. (This again adds to the direct effect on military spending.) Socialist governments have higher CGE than democracies, but military dictatorships and monarchies lower; this alters the picture for military spending, but does not change the rank ordering of types of government. The year dummies become significantly positive in the 1980's.

The key point of this model as distinct from other cross-country estimations of military spending, is that it exhibits military expenditure levels as the product of two separate but intertwined issues: firstly how much revenue the government is able and willing to raise and spend, and secondly, how much of that goes on the military. Whereas the utility maximisation models presented earlier treat the entire national income as being potentially at the disposal of the government, Hewitt's model recognises that money to be spent on the military must first be raised. The main deficiency of the model is the lack of a rigorous treatment of threat factors, but of course its main focus is intended to be economic issues.

The above models all use highly heterogeneous samples, coming from across all developing countries and sometimes developed as well. This gives a broad global picture, but may not accurately represent what happens in particular regions of the world with their own specific characteristics. It would be a brave (or foolish) person who claimed that the processes governing military spending demand in the Middle East for example, were essentially the same as those in Sub-Saharan Africa. Some models therefore seek to focus on a relatively homogenous set of countries from a single region.

Adams and Ciprut (1995) analyse military spending in East Asia, amongst the 'Western oriented' nations, from 1967-1988 (leaving out for example China and Vietnam). . This group thus has a measure of political as well as geographic homogeneity. They use a pooled data estimation, either on its own or with country or time dummies. Taking the dependent variable as military spending per capita (log transformed), they find a positive influence of GDP per capita, but with elasticity clearly less than one; a negative population effect; a negative effect from the ratio of US to USSR military spending (implying some sort of free-rider effect as these are all pro-western countries), and a positive effect from the threat proxy. This is a rather curious measure, taking the sum of distance-weighted military spending (i.e. military spending/distance) for enemies minus the same for allies divided by the total for all countries. This effect becomes insignificant when country dummies are used.

This is again in line with expectations, and confirms Gonzalez and Mahey's negative population effect, though Adams and Ciprut put this down simply to economies of scale rather than the convoluted theoretical devices of the former. The threat proxy seems hard to justify, in that it makes rather a lot of assumptions about the impact of different types of countries' military spending, namely that allied military spending has a clearly negative effect, (assuming enemies' to be positive) while neutral military spending has a diluting effect. (As the measure is (enemies-allies)/(enemies + neutral + allies)). These assumptions require testing. Dividing by distance is plausible, but again assumes a distance elasticity of -1.

Lastly, Mohammed (1996) examines military burden and absolute levels of spending in African countries from 1960 to 1991, using a number of explanatory variables, and using both time-series and averaged cross-section analysis. He finds that war and armed forces size (or force ratio) both have a positive effect. As one would expect, GDP per capita has a positive effect on absolute military spending, but is ambiguous for military burden. The coefficient on trade as a proportion of GNP is insignificant. Land area has a positive effect, but its significance is sensitive to specification. He finds the effect of military government ambiguous.

One potential econometric problem with this model is the inclusion of armed force level or force ratio as an explanatory factor for military spending, as there is likely to be a problem of endogoneity; the size of the armed forces is likely to be highly dependent on the level of military spending.

2.3 Conclusion

This chapter has surveyed the theoretical approaches to analysing the demand for military expenditure, and the empirical analyses undertaken. A very general conclusion that can be drawn is that military expenditure depends on economic resources and threat, and also the political priorities and pressures of a particular country's Government. This process can be modelled mathematically, and analysed empirically. Mathematical modelling may be based on utility maximisation, on game theoretical arms-race scenarios, or on dynamic arms-race models, where it is possible to analyse conditions for stability and instability. Empirical estimations may centre round the interaction between two countries in an arms race, where current research focuses on the co-integration model of adjustment towards an equilibrium relationship, or on cross-country estimations where threat may come from a variety of sources.

Purely strategic models of military expenditure may carry useful insights, but overlook a wide variety of other economic and political factors. In particular dyadic arms race models may be of limited practical applicability, as they depend on situations where two countries are engaged in a rivalry which overshadows other sources of threat. If we are to gain a broad understanding of the determinants of military expenditure worldwide, and in particular in developing countries, it is preferable to start from an economic model, such as the neo-classical utility maximisation approach, which allows for a wide range of economic, political and military variables. While the political theory behind this approach may be open to question, it is empirically very flexible and can easily be adjusted to incorporate ideas such as the bureaucracy model. In the previous section we have described a number of models that take this approach with some success, using a variety of econometric techniques and sets of variables.

The next two chapters will develop one of these models in particular, that of Rosh (1988), which generalises the concept of an arms race by treating a country's military spending as a function of that of all other nations that could affect its security. In particular the specification of the Security Web defined by Rosh will be explored in greater detail.

Chapter 3: The demand for military spending before and after the end of the Cold War: an empirical investigation

This chapter describes an extensive econometric study of the determinants of military expenditure in developing countries during and after the Cold War. We have seen in the previous chapter that a comprehensive model requires the inclusion of economic, strategic and political factors – either starting from an optimisation perspective and incorporating strategic interaction with neighbours and rivals, or starting with a Richardsonian arms race and building in resource constraints and other additional factors. However, as we are looking across the full range of developing countries, it is not possible to start with an arms race with a particular rival as the basis of a model. We therefore will start with a broadly defined utility maximisation model, in which we will include a range of possible factors. In particular, the study aims to produce as comprehensive as possible a set of measures of threat that may motivate military spending, building on the work of Rosh (1988) which uses the idea of a 'Security Web' to generalise the arms race concept across countries. We shall also use the wide range of threat measures included to analyse what if any differences there may be between the Cold War and Post Cold War periods .as to which threats most motivate military spending.

The end of the Cold War represented a major change in the security environment of many countries, not limited to those directly involved in one of the two superpower blocs. Many developing countries had been involved in conflicts where they were used as proxies by one or other superpower. In the post Cold-War environment, this possibility no longer existed. Sufficient time has now elapsed that it is possible to investigate whether the end of the Cold War has had an impact on the determinants of military spending. Of particular interest is the question of whether internal factors have become more important relative to external factors. In a unipolar world, where the only superpower tends to frown upon countries such as Iraq who seek to change the interstate status quo by force, are countries less concerned by regional military build-ups, and relatively more concerned about the possibility of internal strife?

The dataset employed has been constructed from ACDA military spending data, and a number of conflict datasets, which has allowed detailed classification of the types and intensities of threat faced by each country at a given point in time. A full list of data sources, together with a brief discussion of the scope and reliability of the military expenditure data used, is given in appendix 2. In this chapter a cross-section model is used, averaging out the variables for each country over the two periods in question (Cold War 1981-88 and Post Cold War 1990-97). Thus this chapter seeks to pick up sources of variation in military burden between countries. The next chapter will use the same data to estimate a panel data model, to attempt to gauge sources of variation over time.

The first section will introduce the basis of the model to be used, and describe how the various variables used are created. The second section will present the results of the basic cross-section model. The third section will expand upon the basic model, testing various hypotheses and introducing additional variables that have been employed in some of the previous studies discussed in the last chapter. The fourth section discusses some of the results relating to size effects, and the fifth section concludes. Appendix 6 describes a similar exercise carried out for arms imports instead of military expenditure.

3.1 The model

The model used in this study, and that of the next chapter, starts from a broadly neo-classical utility maximisation approach, which is operationalised using a modified version of Rosh's Security Web. In this section a utility maximisation model is outlined, after which the empirical model is described in detail.

3.1.1 **Theoretical model**

In line with the approach described in the previous chapter, we will define a government utility function that depends on private consumption C and Security S, conditioned on political, strategic and demographic variables Z.

$$U = U\ (C, S, Z)$$

It is assumed that the government's priorities as between consumption and security will depend on its political character, and possibly on the role of interest groups such as the military industrial complex, but that the welfare of the population cannot wholly be ignored. The role of particular institutional interactions will not be modelled; the aim here is to produced a broad theoretical model that can be used as an outline for testing empirically the effects of economic, political and strategic variables, especially a wide range of measures of threat.

Security will in turn depend on real military expenditure M and on variables relating to strategic threats. In the empirical model, we shall develop a number of proxies of threat. Here we shall assume they can be summarised in a single variable M_0. With regard to demographic variables, we shall seek to incorporate possible public good and size effects by including population P.

To provide a mathematical specification of the model, we shall use a variation on the Stone-Geary model of section 3.1.3, but with two differences. The first is a simplification, in that we no longer assume that the variable M_0, which represents a minimum level of Security, depends solely on a particular rival's milex, but is assumed to represent threats in general, internal and external. The second involves the role of population. We assume here that Civil expenditure represents essentially private goods, so that civil welfare (and therefore satisfaction with the government) will depend on per capita consumption, C/P, rather than on the absolute level. Military expenditure, however, is assumed to be at least to some extent a public good, so that security will depend on M/S^r, where $0 \leq r \leq 1$. If $r=0$, then military spending is a pure public good, so that one extra dollar will defend a million people as surely as it will defend one; if $r=1$, then military spending behaves as a private good, so that to defend twice as many people to the same level, you need twice as much spending. It is perhaps reasonable to expect that the true position lies between these two; there is likely to be some public-ness effect, but especially if we are comparing across countries, those with higher populations are likely on average to have larger land areas and longer borders. Internal security needs (from the government's point of view) may also be greater. (These questions are discussed further in section 3.4).

With these considerations in mind, we define the government's utility function to be:

$$(1) \qquad U = \alpha Ln((M/P^r)-M_0)+(1-\alpha)Ln((C/P)-C_0)$$

Here, α represents the relative importance of security as compared to civil expenditure ($0<\alpha<1$), the level of security purchased by a given level of military spending is given by $S= M/P^r$, M_0 represents a minimum level of security dependent on levels of threat, and C_0 now represents a minimum level of per capita civil consumption.

The government maximises its utility function subject to this and the budget constraint

(2) $$Y = P_m M + P_c C$$

Where Y is national income and P_m and P_c are the prices of M and C relative to an income deflator. Solving for M, we obtain a demand function that can be written:

(3) $$P_m M = P_m M_0 P^{r} + \alpha(Y - C_0 P_c P - P_m M_0 P^{r}).$$

That is, nominal military spending is a minimum level of $P_m M_0 P^r$ (below which the first log expression in (1) is undefined), plus the proportion α of discretionary income, that is Y minus the minimum levels of (nominal) spending to make both logs defined. In this case, the minimum level of civil spending depends proportionately on income, while the minimum level of military spending less than proportionately. From this, it is clear that M will depend positively on Y and on the threat variableM_0, as well as on the priority parameter α. We may hypothesise that this parameter will depend on the type of government, for example that dictatorships are likely to have higher values of α.than democracies. It is not immediately clear what the sign of population will be, but it is clear from equation (3) that if r=0, that is if security is a pure public good, then population will have a negative effect on military spending, other things being equal. If equation (3) is divided by Y to give military burden ($P_m M/Y$) on the left hand side, it is also not certain whether military burden will have a positive or negative differential with respect to Y. This is discussed further in section 3.4.

3.1.2 Empirical model

For estimation purposes, we will not be able to use equation (3) as it stands. First, We can rewrite it to give M as a share in income Y, rather than levels, to give us the type of demand function commonly used in empirical work (Smith, 1995). (This means we will no longer necessarily expect a positive effect of Y on M/Y). However as specific deflators for military prices are not available in most developing countries, we cannot estimate the equation as specified, but must leave out the price variables; furthermore while it is not impossible to estimate a non-linear functional form of this nature, standard hypothesis tests would not be valid. In addition, it is not clear what would be the nature of the functional relationship between different threat and political variables and the parameters (M_0 and α in particular) they are hypothesised to influence. For practical estimation, therefore, we will use a linear or log linear specification; the model outlined above is used to provide an outline of the types of effects we may reasonably expect to find, but will not be used in its mathematical precision. Thus we will estimate he share of income in GNP, i.e. military burden as a function of income Y, population P, threat variables represented in the equation by M_0, and variables relating to regime type, hypothesised to influence α.

The next step must be to find suitable proxies for political and strategic effects. In this study a major effort is made to develop variables to represent the strategic factors, by developing the Security Web concept of Rosh (1988). We hypothesise that a country's military spending will be affected (positively) by the military spending of its neighbours, and of other countries able to impinge on its security. However a number of important changes are made to Rosh's approach.

Firstly, Rosh makes no distinction between the effect of military spending by allies, enemies and neutral countries in a security web. He very reasonably points out that there are very few if any stable alliances in the developing world which could give rise to 'free rider' effects; but one might well expect that a known rival's military spending would be seen as a greater threat than that of a non-hostile neighbour. This study breaks down a security web into three categories: Enemies, Potential Enemies and others.

Secondly, while still using military burden (military spending/GNP) as the dependant variable for each country, this study uses a different measure to Rosh of the threat represented by countries in the Security Web. Rosh assumes that a country will respond to the relative militarisation of its Security Web as measured by the average military burden. But arguably, a country will be more concerned by the absolute level of threat they face, measured by the total level of military spending of the Security Web. The same military burden will look much more threatening in a large neighbour than in a small neighbour. Rosh's model could be described as "My burden depends on your burden", or the "burden-burden" model. The alternative is "My burden depends on your level", or the "burden-level" model.[12]

As an example of how the burden-burden specification could produce anomalous results, consider a simple Security Web consisting of two unequal neighbours A and B (say two halves of an isolated island), with A larger in terms of national income than B. Consider the 'burden-burden' model, assuming that one of the countries has a higher military burden than the other – say country A's military burden is 2% of GNP, and country B's 4%. But then the average military burden in A's Security Web – consisting only of country B – is 2%, while the average burden in B's Security Web – which consists of country A – is 4%. Thus the country with the higher military burden in its security web, namely B, itself has the lower military burden of 2%, contrary to the expectations of the model.

On the other hand, we may reasonably suppose that the smaller half-island would devote proportionately more resources to the military to partially compensate for the larger size of its rival, but probably cannot afford to fully compensate, and so still has a lower overall level of military spending. Suppose for example that B's GNP is four times A's, so that

[12] There is also the issue of whether the dependent variable should be a level or a burden. This is most easily tested for by seeing if income is significant when burden is the dependent variable, or alternatively (in a log

with the lower military burden, B's military spending is twice A's. This would mean that the country, A, with the higher absolute level of threat (B's military spending) would have the higher military burden – exactly in accordance with the "burden-level" model.

Indeed this is not mere abstraction, but would appear to have some validity in reality. Thus India and Pakistan are two unequal neighbours and rivals. Pakistan consistently has a much higher military burden than India (around double), but India still has the higher level of military spending (by a factor of 3-4). Therefore, this model will use the total level of military spending in the Security Web and its subgroups, Enemies and Potential Enemies, as determinants of the military burden of each country.

Thirdly, variables are included for actual conflict. The Security Web model does not cover internal threat at all, so an index of civil conflict intensity is constructed. Secondly, although military spending in the Security Web, especially Enemy military spending, gives some measure of external threat, it does not fully encapsulate it. An all-out interstate war more than anything else can absorb the full available resources of a nation, requiring the continual replacement of lost equipment, spares, ammunition etc., more than the ordinary need to match a hostile neighbour's peacetime military capacity. Therefore a dummy variable is included for external war.

By including as many different threat variables as possible, and by separating out the military spending of hostile and non-hostile neighbours, the study aims to address the following research questions: Firstly, do countries respond to high general levels of militarisation in the region by maintaining high military burdens themselves, even in the absence of a specific threat from their neighbours? That is, is there a "keeping up with the Jones'" effect? Secondly, following on from this, is the response to military spending by

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transformed specification) whether the coefficient of log Y is 1 when log M is on the left hand side. Thus hostile neighbours distinguishable from this general response to high levels of militarisation in the region?

Threats to security can be internal or external. An important observation of contemporary international relations is that internal conflicts have become far more prevalent in relation to external conflicts in recent years, especially since the end of the Cold War. Might this affect patterns of military spending? The third question we address is therefore: has civil conflict become a more significant determinant of military spending relative to external threat since the end of the Cold War?

3.1.3 Weaving the Security Web

We now describe how the Security Web, Potential Enemies and Enemies categories were constructed for each country. The study largely follows Rosh in determining which countries are to be included in a country's overall Security Web: neighbours (land or sea), regional powers capable of projecting their influence beyond their borders (e.g. Nigeria in West Africa), other countries able to effect a country's security. Again, following Rosh, superpowers have generally been excluded from a Security Web, as most countries could not realistically expect to defend against them (at least in terms of traditional defence). Their huge military spending would thus distort the figures. However two additional dummy variables were used initially: Great Power Neighbour and Great Power Enemy to take account of relations with superpowers. China and the UK (an enemy of Argentina) were treated as half a great power for this purpose. As the Great Power Neighbour dummy didn't work, separate dummy variables were introduced for proximity to China (China's neighbours and those bordering the South China Sea); the US (for Central America and the Caribbean); and for the USSR/Russia. The exception to this was that China was included

one could also have a "level-level" or (less plausibly) a "level-burden" model.

in India and Taiwan's Security Web, and the China dummy set to 0, as these two countries clearly do seek to directly rival China's military capability, at least in a defensive/deterrent context.

To divide a country's Security Web into Enemies, Potential Enemies and Others, a number of datasets on armed conflict and international disputes have been used: the Dyadmid database of dyadic Militarised Interstate Disputes, the KOSIMO database of violent and non-violent conflicts, the CASCON database of conflict case-studies, and the Upsalla University Department of Peace and Conflict Research conflict database. To qualify as Enemies at a given time, two countries must either currently be engaged in some form of armed conflict (possibly short of all-out war), or must have gone to (all-out) war in the past, with the grievance still unresolved. Thus the continuing dispute over Kashmir makes India and Pakistan enemies, even during the times when they are not at war. (However, for example, Israel and Jordan ceased to be enemies following the Peace Treaty of 1994).

To qualify as Potential Enemies, countries must be involved in a dispute with either a history of or clear potential for militarised confrontation. The KOSIMO database of violent and non-violent conflicts is very detailed, and includes information on all steps taken by a party to a dispute, such as "fully fledged war", "intervention or invasion", "military force", " sporadic military incidents", "dispatching troops or vessels", "concentrating troops on border", "breaking diplomatic relations", "breaking agreements" "trade sanctions", "notes of protest", "mediation", "negotiations", "agreements", "fulfilling demands", etc. Anything involving a show of force (e.g. "dispatching troops or vessels") is treated here as making countries Potential Enemies so long as the dispute continues. "Breaking diplomatic relations" etc. is treated as borderline, with classification depending on what other factors are present.

In adding up the military spending of Enemies (E), Potential Enemies (PE) and Security Web (SW), each has been included as a subset of the next: E as part of PE and PE as part of SW. Thus in the regression analysis, the coefficient of PE will indicate the additional effect of a country being a rival rather than a friendly or neutral neighbour, and the coefficient of E the differential effect of being an outright enemy rather than merely a potential enemy. Appendix 1 gives full details of each country's Security Web, along with other variables such as war status.

In addition to the Security Web variables, measures of internal and external conflict have been included as regressors. Again using the conflict databases, an index of civil conflict ranging from 0 to 4 has been constructed for each country-year. Level 4 represents all-out, generalised civil war; level 1 would apply to situations such as China in Tibet (where strong military force is used against non-violent or disorganised opposition) or Northern Ireland post-ceasefire (not in the sample of course), where an armed opposition remains despite a general absence of actual fighting. For external war, a simple dummy variable is used.[13] This variable is set to 1 only where either the KOSIMO or the Dyadmid database indicates the highest level of conflict between two states, as it is intended to cover only those situations where a country's resources are employed to an extraordinary degree in the course of all-out war; lesser degrees of external conflict are considered to be adequately represented by the designation of neighbours as Enemies or Potential Enemies.

The use of war and Security Web variables attempts to measure specific threats, immediate and potential, that a nation may face. However it is probable that there are other factors, possibly indirect, that we have not captured. Regional factors in particular may be important. The Middle East for example is an area of very high military spending. Part of this will be captured by the actual wars that have been fought during the periods in question, and by the variables for Security Web, Enemies etc. However it is possible that there is an additional externality effect of present and past wars in the Middle East, in that these wars make the region a "bad neighbourhood", and cause all countries, even those not directly involved in hostilities, to raise their military spending. A dummy variable for the Middle East has therefore been included. (Recall also that dummies have been included for proximity to the USA, the USSR and China.) This will also provide a control for any positive effect that may be detected from the Security Web variables; do neighbouring countries tend to have jointly high military spending because they respond to each other's spending, or because they are all responding to common external circumstances?

Thus the full list of threat variables used in the model is: total Security Web military spending (including both subgroups), total Potential Enemies military spending (including Enemies), total Enemies military spending (all these three logged); External War, Civil War, dummies for Middle East, China, US and USSR proximity, and Great Power Enemy.

We now move on to political variables. It is widely found (e.g. Rosh (1988), Hewitt (1991)), that democratic countries spend less on the military than non-democracies. There are many possible reasons for this. Firstly, autocratic states usually rely at least partly on the military to retain their grip on power. Secondly, dictatorships often rely on a culture and ideology of militarism to justify their rule. (This can also be present in democracies, but is perhaps more marked in non-democracies). Thirdly, totalitarian states are perhaps more able than democracies to maintain unjustifiable and inefficient levels of spending by the military and other Governmental departments in pursuance of the interests of the public elite rather than the country as a whole (implying a 'corruption' or 'bureaucracy' model of spending rather than a neo-classical utility maximisation model). Whatever the interpretation, the effect is widely observable.

[13] Note that since all variables are averaged over an 8-year period, dummy variables will not necessarily take

The POLITY 98 database, which gives figures for democracy and autocracy, broken down into various subcategories, for all states from 1800 onwards is employed in this study. This only covers the institutional aspects of democracy; the competitiveness and openness of executive recruitment, constraints on executive power, diversity of levels of power, etc. Factors such as respect for human rights, press freedom, etc. are not counted. Thus states such as Turkey which have fairly open elections but which routinely practices torture will count as mostly democratic. While this may seem a little incomplete, for these purposes it is quite a useful measure; the fact that a Government can be replaced and that there are limitations on executive authority may strongly discourage excessive or wasteful militarism, even if repressive measures are used in other respects. The variable used is the DEMOCRACY variable minus the AUTOCRACY variable.

Finally, population and GNP (log form) are included as variables to capture possible size and public good effects. Reasons for why these may operate in one direction or the other are discussed in section 3.4.

The full list of variables, with sources and definitions, is given in appendix 2.

3.1.4 Econometric issues

The model used, being a single equation model, carries a potential problem of endogoneity, in that the Security Web variables are clearly endogenous, as the military burden of the country in question will influence the military spending of the countries in the Security Web. This will in principle lead to biased and inconsistent estimators. However there are a number of factors that may mitigate this problem.

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a 0 or 1 value in the averaged data.

Firstly, the military spending of the "dependent variable" country is only one of those that will influence the military spending of the countries in the Security Web – all the other countries in their Security Webs will have an influence, as well as the other relevant factors, such as GNP, democracy, population etc. Secondly, the independent and dependent variables are of different types, namely the independent variable is a burden, whereas the dependent is a level. If the previously-stated hypothesis about the nature of influence of one country's military spending on another's is correct, then the influence from level of X to burden of Y is stronger than from burden of Y to level of X.

In other words it is reasonable to hope that the simultaneous effect of the dependent variable on the Security Web variables is sufficiently "diluted" that it will not lead to significant bias and inconsistency. The problem of endogoneity will be tested for later.

The issue of endogoneity also raises questions as to the interpretation of results. The problem is common in many branches of social sciences, and relates to the effect of the group on the individual. In this case, the 'group' is the Security Web of an individual country. Manski (1993) discusses this 'reflection problem' in the context of social psychology, and argues that 'inference on endogenous effects is not possible unless the researcher has prior information specifying the composition of reference groups' – that is, it is difficult if not impossible to identify causality when we are looking for effects of the group on the individual, so that influences are endogenous and reflective. In particular, observations of correlated behaviour amongst a group may indeed be due to *endogenous effects* - each individual following the common pattern (a country's military spending is influenced by that of their neighbours), or because of *exogenous effects* – wherein the propensity of an individual to behave in some way depends on the exogenous characteristics of the group (for example countries in a region of high tension may all tend to have high military burdens), or *correlated effects* – wherein individuals in the same group tend to behave similarly because they have similar individual characteristics (for example if nearby countries tend to have similar levels of wealth, and that is a determinant of military burden).

To some extent we may be able to control for this, for example by including regional variables. In chapter 4, when considering panel data results, some effort will be made to distinguish between different possible patterns of causality. Also, as Security Webs are not equivalence classes of nations but are overlapping, the issue of groups acting on individuals is not precisely as set out above. Nonetheless, a certain degree of circumspection must be applied in concluding causality from any results we may obtain from this analysis.

In addition there is a very severe problem of multicollinearity. The Security Web, Potential Enemies and Enemies variables are correlated by design. The External War variable will tend to be correlated with high levels of Enemies military spending in particular. The Great Power Enemy variable is likely to be correlated with high Enemy/Potential Enemy military spending and with External War. Countries who have made an enemy of a Superpower are likely to have made other enemies as well, and war may be either the cause or the effect of such enmity. However, non-perfect multicollinearity violates none of the assumptions of classical regression and still gives unbiased, efficient estimators. It will mostly become apparent from the results if there is a problem, namely if we encounter high R^2 values but poor t-ratios, and other typical features of mulicollinearity.

3.2 Sample, data sources and empirical analysis

Data for military spending is obtained from the American Arms Control and Disarmament Agency (ACDA 1991, 1998) for the two periods 1980-88 (During the Cold War) and 1990-97 (Post Cold War). (1989 is not included in either sample as it was in many ways a transitional year.) The definition and reliability of this data is discussed briefly in Appendix 2.

The study excludes the 'developed' world; more specifically it excludes that portion of the industrialised world that forms or formed part of the stable alliances systems. Thus most of Europe, USA, Canada, Japan, Australia & New Zealand are excluded. The justification is that where a country's neighbours are stable allies, the response to their military spending is likely to be rather different, and ambiguous; there may be a 'free rider' effect, or a follower effect, or these effects may cancel out. Also when considering superpowers, their "Security Web" would need to be much more broadly defined.

Data for military spending is inaccurate and incomplete, for many reasons. Military expenditure totals are often kept secret or falsified. Military spending may sometimes be hidden in other budget lines. Some countries do not include arms purchases in their military spending totals, and the retained profits of military industries are typically excluded. Thus, most observations are to a greater or lesser extent estimates, and in many cases ACDA have declined to attempt an estimate. To maximise the sample size therefore, we have not required observations for a country for each of the eight years in a period, but have included a country if there were five or more readings for the period concerned. As a result, there are 93 countries in the 1981-88 study, and 111 countries for 1990-97.

The two datasets are not directly comparable. Firstly the samples are different, and secondly there has been much revision of ACDA's methods of calculation between the two datasets; on the years they overlap, there are radically different figures between the two for the same country-year.

As noted, data on conflict and rivalries was constructed using the Dyadmid database of dyadic Militarised Interstate Disputes, the KOSIMO database of violent and non-violent conflicts, the CASCON database of conflict case-studies, and the Upsalla University Department of Peace and Conflict Research conflict database.

National Income and population data also comes from the ACDA tables. Data on democracy comes from the POLITY98 database of democracy vs. autocracy.

The problem of missing military expenditure data carries through to the Security Web variables. Clearly missing country-years cannot be included in a country's average in the sample – however it would be unfortunate if all the neighbours of this country also had to have that year excluded from their averages due to incomplete Security Web data. Hence, missing figures have therefore been "guessed" whenever this was at all reasonable, not of course to be used as part of the dependant variable, but to be used as an explanatory variable. Usually the most recently available figure for military burden has been applied to the current level of GDP to interpolate a figure. Sometimes an immediately subsequent figure has been used, and occasionally missing years have been interpolated more or less linearly when there has been a big change between two available figures. One cannot claim any remote degree of accuracy for such a process, though it may mirror what a country's government would have to do to estimate and respond to the behaviour of a non-transparent neighbour. Where there is an almost complete absence of data (e.g. Afghanistan, Somalia), no attempt has been made to guess a figure, but a separate "Unknown Threat" variable has been included for this country's neighbours; this being equal to the population of the country whose military spending is unknown, doubled for a Potential Enemy and quadrupled for an Enemy.

Table 1 below gives summary statistics for the variables in the two periods. Military spending and GNP figures are measured in constant US$1997 for the Post Cold War period, and constant US$1991 for the second, re-based in this table, though not in the regression, to 1997.

Table 1: Summary statistics for the main variables for each period.

	Cold War		Post Cold War	
Variable	Mean	Coeff. Var.	Mean	Coeff. Var.
Military Expenditure	2415.767	2.87	2203.98	2.98
GNP	43468.83	2.80	66033.58	3.75
Population (millions)	37.94	3.53	38.67	3.67
External War dummy	0.056	3.84	0.024	3.85
Civil War dummy	0.76	1.78	0.98	1.31
Total military Expenditure of Enemies	2866.315	3.24	2312.89	3.76
Total military spending of Potential Enemies	7868.509	5.47	4704.92	2.93
Total military spending of Security Web	19698.22	4.12	13801.33	2.73
Great Power Enemy dummy	0.08	3.46	0.06	3.90
Polity 98 Democracy-Autocracy	-2.74	-2.34	0.37	17.83
Military Burden (Military expenditure/GNP)	0.053	1.15	0.043	1.16

For each of the two periods, Cold War and Post Cold War, a simple log-linear regression[14] is used to estimate the demand for military spending. Log Military Burden is regressed on a constant, log GNP, log population, External War, Civil War, log Security Web military spending, log Potential Enemies military spending, log Enemies military spending, log "Unknown Threat", Democracy, Middle East dummy, China, US and USSR dummies, and Great Power Enemy dummy. Each variable is averaged over the 8-year period in question.[15]

Table 2 below gives the results of the regression for the Cold War period, 1981-1988. The second and third columns are the results for the full model with all the variables. An F-test was performed for the joint deletion of the most insignificant variables in this model: log GNP, log Enemies military spending, log Unknown Threat, US and USSR. (Security Web and Great Power Enemies were initially left in as they were close to being significant.) This was very strongly accepted. Log Security Web Military spending was now significant, but Great Power Enemy remained insignificant and was deleted. The fourth and fifth columns therefore list the results for the reduced model with these variables deleted. Table 3 shows summary statistics and the results of some standard diagnostic tests for the two models.

The results seem to show most of the effects we would expect. Military burden does indeed increase with the level of military expenditure in the surrounding region, and it is also clear that the extra spending of hostile countries (Potential Enemies or Enemies) has a more marked effect. The Middle East dummy is highly significant and positive, indicating that there are strong externalities generated by the history of conflict and tension in the region. However this does not nullify the significance of neighbours' military spending.

[14] For each period the log linear specification was tested against a linear specification. Log linear was preferred for both periods.

The China dummy is also highly significant; recall that this has been applied to countries for whom China has not been included in Security Web military spending, as it was thought possible this might have a distorting effect, as countries may not be able to defend against such a threat. However these results suggest either that these countries (neighbouring China or bordering the South China Sea) either do regard China as a threat against which military expenditure is effective, or that there are other regional factors not otherwise captured by the data.

The insignificance of the Enemies' military spending variable does not mean that an enemy's military spending is unimportant; as Enemies are included in PE, and PE are included in SW, the effects are cumulative; thus what this says is that it makes no significant difference if a country is an Enemy or merely a Potential Enemy. In other words, the distinction between Enemies and Potential Enemies may be too fine, the only relevant one being between hostile and non-hostile neighbours. Alternatively, there may be a problem of multicollinearity.

The Great Power Enemy dummy did not prove significant; countries with this variable set to 1 were mostly US enemies, which suggests that such countries do not treat US power as a threat they can defend against – or that in the Cold War environment, they look to the USSR or China. Turkey also had a Great Power Enemy status – but then they have NATO support to counterbalance this. It is possible that the insignificance of this variable is a result of multicollinearity with the war variables and Potential Enemies, etc.

External War is clearly very important, with a much higher coefficient than Civil War. This may reflect the much more 'low-tech' and therefore less expensive nature (at least

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[15] For the log variables, the log of the average is used as opposed to the average of the logs. As the Security Web variables sometimes take zero values, we add one to the figure in millions of $US 1995 before taking logs.

militarily) of civil wars. The negative population co-efficient is interesting; this may suggest either that a large population is considered to offer some autonomous security in itself, or that small countries have to spend more on hi-tech weaponry rather than relying on a large army; or that high populations generate greater additional civilian needs than security needs, in line with the notion of military expenditure as a 'public good'. (In terms of the model of section 3.1.1, a low value of r is suggested). As both GNP and population are include in the model, there is some possible confusion about the nature of the interaction of these two with military burden; however the negative population effect remains just as strong if GNP is replaced with GNP per capita (which also proves insignificant), or, as is seen from Table 2, if GNP is removed altogether. The population effect also does not vanish when two extreme cases, the population giants of China and India, are excluded. The insignificance of log national income in explaining log military burden suggests that across countries the income elasticity of demand for military spending is one. Large and small economies, other things being equal, are equally likely to devote a high or low share of their resources to the military. These questions of scale, that is the effect of the size of population and income on military burden, are considered in more detail in section 3.4. As can be seen from table 3, there do not seem to be any serious specification problems with the model. The R-bar squared of 0.62 for the reduced model is fairly good for a cross-section model.

As discussed in section 3.1, there is a potential problem of endogoneity in this model, in that the variables for Security Web and Potential Enemies' military spending are likely to be affected by the dependant variable, the military burden of the country in question. Endogoneity was tested for as follows:

Log Security Web military spending and log Potential Enemies military spending were regressed on all the other significant independent variables from the above regression, and also on log GNP, and the logs of the average aggregate incomes of the groups concerned (Security Web or Potential Enemies). The fitted values from these regressions were saved, and a variable addition test was performed to add these fitted values to the reduced model regression. The fitted values were jointly and individually insignificant (by F, LR and LM tests), even at the 10% level. We may therefore conclude that there is not a significant problem of endogoneity. This test was only performed for the Cold War sample.

Table 2: Regression results for Cold War period.

Dependent variable is log military burden, 93 observations.

	Full model		Reduced form	
Regressor	Coefficient	T-Ratio	Coefficient	T-Ratio
Constant	***-3.98	-8.9	***-4.21	-22.7
Log GNP	-0.017	-.3		
Log Population	***-0.18	-2.7	***-0.19	-3.9
External War	*0.55	1.7	**0.70	2.4
Civil War	**0.11	2.2	**0.092	2.0
Log Security Web Milex	0.053	1.6	**0.064	2.2
Log Potential Enemies Milex	***0.082	3.1	***0.091	4.5
Log Enemies Milex	0.003	0.1		
Log Unknown Threat	0.11	1.3		
Democracy	***-0.033	-3.1	***-0.035	-3.6
China proximity	***0.64	3.0	***0.70	3.7
Middle East	***0.76	3.4	***0.67	3.3
US proximity	-0.17	-0.8		
USSR proximity	-0.22	-0.6		
Great Power Enemy	0.40	1.5		

(* = significant at 10% level, ** = significant at 5% level, *** = significant at 1% level.)

Table 3: Model statistics and hypothesis tests for Cold War regression.

For the last three rows, the bracketed figures are $P(X>x/H_0)$ where H_0 is, respectively, correct functional form, normality of residuals, and homoskedasticity).

	Full model	Reduced model
R^2	0.67	0.65
R-bar-squared	0.61	0.62
Standard Error of regression	.56	0.56
Log likelihood	-70.6	-72.7
Ramsey's RESET test (CHSQ(1))[16]	2.65 (0.10)	2.1 (0.14)
Bera-Jarque normality test (CHSQ(2))	3.53 (0.17)	1.7 (0.42)
White Heteroskedasticity test (CHSQ(1))[17]	0.002 (0.97)	0.09 (0.77)

The results for the Post Cold War period were similar in many ways to those for the Cold War. One change that was made was in the specification of the Civil War variable, which did not initially prove significant. The variable was re-coded to take a value of 1 if its average value over the period was 3 or higher (out of a maximum of 4), and zero otherwise. Thus it became essentially a dummy variable for the existence of a large-scale and long-lasting civil war during the period. Also the Unknown Threat variable was not used in this model as it had proved completely insignificant for the Cold War period.

[16] Using the square of the fitted values
[17] Based on the square of the fitted values

Table 4 below gives the regression results for the full model and for the reduced model with insignificant variables removed. (Log Enemies military spending and Great Power Enemy are left in although insignificant, as they were jointly significant at the 10% level.) Table 5 again gives summary statistics and diagnostics.

The most striking thing about this result is the total insignificance of the External War variable. This is probably partly due to the fact that there are very few external wars: Iraq's invasion of Kuwait, Israel's occupation of the Lebanon, the brief Peru-Paraguay war of 1995, Vietnam's continuing involvement in Cambodia at the start of the period, and Azerbaijan's war with Armenia. (Armenia is not themselves in the sample due to lack of data; for Cambodia this is considered as a Civil War only, as Vietnam was on the Government side). Of the 8 countries involved that are in the sample, 4 are in the Middle East, which has its own dummy variable. In addition, Iraq has Great Power Enemy status, and Iraq and Israel both have high totals for enemies' and potential enemies' military spending. Thus the External War variable could be a victim of lack of variation and multicolinearity. (Some of these 'External Wars' are a bit questionable – Israel's occupation of the Lebanon was counted at half value, as it is not really an all-out war. Discounting this as a war does not improve the result.)

Otherwise, the results are not greatly different from the Cold War, though the coefficients on the Security Web variables and the regional dummies are smaller. Of course the two datasets are not properly comparable, so firm conclusions may not be drawn from this, but this may be an indicator of an improved security environment in which neighbours' military spending and regional circumstances are not so threatening. Other than External War, all the significant variables from the Cold War period remain significant, with only the marginally significant joint addition of log Enemies military spending and Great Power Enemy. At first sight the Civil War coefficient seems much higher, 0.27 instead of 0.094, but this has been re-coded from a scale of 0-4 to a scale of 0-1. Given this, the increased coefficient is about in line with expectations. Again, the negative population effect remains regardless of the inclusion or exclusion of GNP or GNP per capita in the equation. The R-bar squared is slightly smaller at 0.58 instead of 0.62. Again we find that there are no significant problems of mis-specification, non-normality of residuals, or heteroskedasticity.

Table 4: Regression results for Post Cold War period.

Dependant variable is log military burden, 111 observations.

	Full model		Reduced form	
Regressor	Coefficient	T-ratio	Coefficient	T-ratio
Constant	***-3.86	-11.3	***-3.99	-22.3
Log GNP	-0.004	-0.1		
Log Population	***-0.14	-2.7	***-0.14	-4.0
External War	0.15	0.2		
Civil War	*0.28	1.9	*0.27	1.8
Log Security Web Milex	*0.042	1.6	**0.048	2.0
Log Potential Enemies Milex	**0.047	2.3	***0.054	2.7
Log Enemies Milex	0.031	1.4	0.030	1.4
Democracy	***-0.035	-4.0	***-0.038	-4.7
China proximity	**0.36	2.4	**0.34	2.4
Middle East	**0.49	2.4	**0.44	2.3
US proximity	-0.22	-1.2		
USSR proximity	-0.29	-1.5		
Great Power Enemy	0.36	1.4	0.32	1.3

Table 5: Model statistics and hypothesis tests for Post Cold War regression.

(see Table 3)

	Full model	Reduced model
R^2	0.62	0.61
R-bar-squared	0.58	0.58
Standard Error of regression	0.52	0.52
Log likelihood	-76.7	-78.6
Ramsey's RESET test (CHSQ(1))[18]	2.2 (0.13)	1.6 (0.21)
Bera-Jarque normality test (CHSQ(2))	0.91 (0.64)	0.22 (0.90)
White Heteroskedasticity test (CHSQ(1))[19]	0.34 (0.56)	0.45 (0.50)

3.3 Further tests and alternative specifications

The above results provide a fairly satisfactory empirical model of the determinants of military expenditure across countries. In this section we will look at the model in more detail, testing in particular alternative specifications of the Security Web, including Rosh's original model which uses the average military burden of the Security Web. An attempt is also made to test whether the coefficients of the variables have changed between the two periods.

[18] Using the square of the fitted values
[19] Based on the square of the fitted values

3.3.1 The restoration of China

First of all, we test a relatively minor issue regarding the construction of the Security Web variables. The original specification of the Security Web supposed that most countries cannot expect to defend themselves against superpowers, with the US, Russia and China put into this category. Accordingly, their military expenditure was left out of the Security Web totals (except in the case of India and Taiwan where China's military spending was counted as Enemy military spending and thus also as Potential Enemies and Security Web). Dummy variables were included for proximity to these three. Of these, only China was significant, and indeed was highly positive. The US dummy actually tended to be negative, though insignificant. It is possible therefore that the exclusion of China's military spending was in error. Accordingly revised Security Web figures were constructed which included China's military spending in the totals for those countries with the China dummy set to 1. (China was also included as a Potential Enemy in the case of South Korea).

The result was that in both samples the significance of log Security Web improved somewhat. Interestingly, the China dummy remained significant in the Cold War sample, suggesting that there is some "regional tension" effect here akin to the Middle East that has not been adequately captured.[20] In the Post Cold War period, the China dummy becomes insignificant, perhaps reflecting the defusing of these ideological tensions, as China moved more towards capitalism and participation in the global economy.

The R-bar squared improved slightly to 0.63 in the Cold War model (reduced form), but actually fell very slightly for the Post Cold War. The significance of other variables is not

[20] Alternatively, perhaps China should have been coded as a Potential Enemy for more of the countries in question; for example, the dispute over the Spratly Islands only showed up in the databases I consulted to a significant degree between China and Vietnam, whereas the Philippines and Malaysia are also involved. In

affected, except that Great Power Enemy becomes significant (10% level) and positive for the Post Cold War period.

3.3.2 'Nesting' of the Security Web variables

As discussed, the Security Web variables have been specified in a nested form, that is with Potential Enemies included in Security Web and Enemies included in Potential Enemies. The reason for that was to detect if additional effects could be observed for spending by more hostile powers as distinct from less. However this approach is clearly open to question, the alternative being to look at the three categories of non-hostile, somewhat hostile and very hostile separately.

The original specification was tested against the latter using a number of non-nested tests: a J-test, an N-tests and an encompassing test. This was carried out for both samples, and using the data with Chinese military spending included. The Enemy military spending total was included in the regression despite its insignificance, so as to fully test the model with the three nested categories against that with the three separate categories. All other explanatory variables which had proved significant in the regressions in section 3.2 were used in both the alternative models for the test. The result, for both samples, was that all the tests used accepted the original specification and rejected the alternative specification.

3.3.3 Testing the "burden-level" specification

The model of demand for military spending estimated here assumes that a country's military spending is influenced positively by the military spending of its neighbours, hostile or otherwise (though more so for hostile).

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addition there is the ideological tension between China and many of her neighbours which I have not

More specifically, however, the model postulates that country A's military burden is influenced by its neighbours' absolute military spending. This has been referred to as the 'burden-level' model.

There seems to be a good case for taking military burden as the dependent variable, as no model estimated so far has found the income variable to be significant. However there are strong arguments for the claim that what influences this is neighbours' military spending level rather than burden, as argued in section 3.1. Rosh (1988) assumes that it is neighbours' military burden: the 'burden-burden' model.

An initial test (carried out for the Cold War and Post Cold War samples) was for a "spurious income effect." The reasoning is this: richer countries tend to be near other richer countries; in general this will tend to mean that a country's GNP will be correlated positively with those of its neighbours. (Not that strongly, as a large rich country could border a small rich country). But furthermore, a large country, which on the average will have a high GNP, will tend to have lots of neighbours, and so will have a high aggregate for neighbours' military spending. If the burden-level model is correct, this will mean that higher income countries (whether through wealth or size) will tend to have a higher military burden, because their neighbours, also mostly richer countries, will tend to have a higher absolute level of military spending (or will consist of numerous countries adding up to a high total). If on the other hand the correct model is burden-burden, we would not expect this effect.

Log Military Burden was therefore regressed on a constant, income, population and the war and democracy variables, but leaving out the variables for Security Web military

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counted in Potential Enemy classification spending (and also Potential Enemies and Enemies), as well as the regional dummies. The results for the 1981-88 period are in Table 6 below:

Table 6: Regression results (Cold War) for the 'spurious income effect'.

Dependant variable is log military burden, 93 observations.

Regressor	Coefficient	T-Ratio
Constant	-5.26	***-10.0
GNP	0.23	***3.3
Population	-0.23	***-3.1
External War	1.17	***3.1
Civil War	0.14	**2.3
Democracy	-0.057	***-4.6
Adjusted R^2	0.32	

The log income variable is highly significant and positive. However when either the Security Web variables or the regional variables are added back in, GNP ceases to be significant, and indeed the coefficient becomes negative when all are included. The post-Cold War period gave less clear results, with a t-ratio on LY of just over 1.6, which was not quite significant even at the 10% level. However once again the sign of the coefficient went from negative to positive. There does therefore seem to be some support for the spurious income effect predicted by the burden-level model.

A more explicit test between the two models (carried out for the 1981-88 period only) can be conducted by bringing in variables for the total income of the Security Web and Potential Enemies, to see if they would be significant when added to the model.[21] The burden-level model, whereby it is only a neighbour's absolute level of military spending which makes a difference, would predict that these variables would be insignificant. If on the other hand it is neighbours' military burden that matters, then we would expect a negative coefficient.[22] The results are in Table 7 below:

Table 7: Regression results for Cold War period with aggregate income of Security Web and Potential Enemies.

Dependant variable is log military burden, 93 observations.

Regressor	Coefficient	T-Ratio
Constant	***-4.251	-20.384
Population	***-0.191	-3.982
ExternalWar	*0.609	1.985
Civil War	*0.090	1.932
Security Web Milex	-0.053	-0.457
Security Web GNP	0.086	1.007
Potential Enemies Milex	**0.221	2.030
Potential Enemies GNP	-0.089	-1.176
Democracy	***-0.034	-3.556
China proximity	***0.728	3.657
Middle East	***0.776	2.904
Adjusted R^2	0.62	

Potential Enemies' military spending remains significant, while Potential Enemies income

[21] Enemies income was not included as Enemies military spending had proved insignificant.
[22] Specifically, the "burden-burden" model takes the form: log Military Burden = B0 + B1*(log SW Military spending – log SW GNP) + …, so that the coefficients on Security Web military spending and Security Web GNP are equal and opposite, similarily for Potential Enemies.

is negative but insignificant, suggesting that it is indeed absolute levels of military spending rather than burden that is important. The inclusion of the Security Web income variable renders both it and the Security Web military spending variables insignificant, with the military spending variable actually negative. These two variables are highly correlated (r=0.94) which partially explains this, though the figures for Potential Enemies are even more highly correlated (r=0.98). Interestingly, using Security Web GNP instead of military spending yields a significant positive result; so from these results it is not possible to determine whether the relevant influence is the military spending of (non-hostile) neighbours or simply their absolute economic size. The burden-burden hypothesis, that the coefficients of Security Web and Potential Enemies income are equal and opposite in sign to those for Security Web and Potential Enemies military spending respectively, is strongly rejected by a Wald test.

Creating variables specifically for the military burden of the Security Web and Potential Enemies presents difficulties, due to the number of countries with an empty Security Web or Potential Enemies set, which would give a figure of 0/0 for military burden. A reasonable approximation was used by letting Burden = military spending/(GNP+1), with military spending and GNP both measured in $m, making the addition of 1 to GNP fairly minor, and then setting log Burden to be Ln (Burden+.001).

If the burden variables for Security Web and Potential Enemies are used instead of the military spending variables, they are still both significant and positive, but the R-bar squared drops from 0.62 to 0.56. Non-nested tests clearly prefer the specification with the military spending levels rather than the burdens.

If both the burden variables and the income variables are included, we find, somewhat surprisingly, that both the Security Web and Potential Enemies income variables are significant and positive, while the burden variables are clearly insignificant. This may seem to suggest that it is only the absolute size of the neighbouring/hostile economies that makes a difference; against this it should be noted that the burden variables are rather awkwardly defined, and that when both Potential Enemies military spending and income are included, it is the military spending variable that is significant.

Overall these results suggest that the model using the absolute level of military spending in hostile countries as a determinant of military spending is to be preferred, but that there is very little to choose between using the level of military spending or the level of income in the general Security Web. At any rate, using the military burden in these groups does not seem to be the best model. Thus these results would appear to show considerable support for the 'burden-level' model.[23]

3.3.4 The "Curse of Wealth"

The burden-level model, which receives strong support from the above results, tends to suggest that richer countries and regions will have higher military burdens. This is not a direct, but an indirect effect, which one could nickname the 'curse of wealth'. For suppose that every country in a region doubles its income overnight. (of course this supposes that these cross-section results would extend to changes within countries.) Initially, they would all double their military spending to keep the same proportion of income. (This would be partly to counter the increased strength of their neighbours, and maybe partly to 'power project' in accordance with their new status as rich important countries). There would be a big influx of arms into the region. Now all of these countries would look around and feel a little nervous – the region has become a more dangerous place. Even though the ratios of military capability have not changed, there is a greater absolute level of threat, more high

[23] The country's own income (variable LY) is not significant in any model.

technology weapons, generally more dangerous possibilities. To counter this, all countries further increase their military spending, thus leading to a higher military burden. Greater wealth has actually made everyone feel less secure.

As we have only estimated a cross-section model, the above scenario does not follow directly from the results. However the effect described does arise as an intriguing possibility which could be the subject of further research.

3.3.5 Testing for a structural break between the periods

The results in section 3.2 were ambiguous as to whether there has been a significant change in the pattern of determinants of military spending between the Cold War and Post Cold War period. With the exception of External War (possibly insignificant due to lack of variation Post Cold War), the same set of variables were individually significant. However there was some evidence that the coefficients of the Security Web and regional variables were lower in the second period. To test this, the averaged observations for the two periods were merged into one data set – that is the 1981-88 averages for each country were pooled with the 1990-97 averages, giving a total of 93 + 111 = 204 observations.

There is a problem of data compatibility in this exercise. First of all there is the issue of currency conversion, in that the Cold War figures were in constant US\$1991, and the Post Cold War in US\$1997. Proper conversion from 1991 to 1997 figures requires conversion to local currency at the 1991 rate, deflating to 1997 prices using the local currency deflator, ten converting to dollars at the 1997 rate. Unfortunately, the relevant information was not available in all cases. In these cases the US deflator was used instead. (In some of these cases, such as the former Soviet Union, PPP conversion had been used by ACDA anyway, so this would not be a problem). However there seems also to have been a change in the method of data collection, in that ACDA sometimes give different values of military burden for the same country in the same year for those years where the datasets used overlap. There does not seem to be any consistent pattern in the way figures have changed. One can only hope that it will still be possible to get meaningful results despite this.

Log military burden was regressed on the full list of variables using the combined sample, and then a Chow test for structural stability was performed, separating out the Cold War observations from the Post Cold War. The results of the combined regression are shown in Table 8 below. As always, military burden, income, population and the security web etc. military spending totals are in logs. Diagnostic tests indicate no problems of misspecification or heteroskedasticity.

Table 8: Regression results for both periods combined.

Dependant variable is log military burden, 204 observations.

Regressor	Coefficient	T-Ratio
Constant	***-4.00	-15.2
GNP	-0.002	-0.1
Population	***-0.16	-3.8
External War	*0.49	1.8
Civil War	***0.083	2.6
Security Web	**0.049	2.6
Potential Enemies	***0.060	3.9
Enemies	0.022	1.4
Democracy	***-0.033	-5.2
China proximity	***0.48	3.9
Middle East	***0.58	4.0
US Proximity	-0.20	-1.5
USSR Proximity	-0.18	-1.1
Great Power Enemy	**0.36	2.1
Adjusted R^2	0.61	

This is very similar (not surprisingly) to the separate results, though in many cases the t-ratios are improved. The income variable is still insignificant. Interestingly a period dummy, set at 0 for the Cold War and 1 for the Post Cold War period, proved utterly insignificant when added to the regression. This is not as surprising as it may seem, as the end of the Cold War means lower values both for dependent and 'independent' variables: lower military spending all round, and therefore lower values for Security Web and

Potential Enemies military spending; also less wars. Thus the Post-Cold War environment is described by this reduced general level of military spending and the factors known to influence military spending.

In the combined sample, the US proximity variable comes nearer to being significant (negative), but is still insignificant. The Great Power Enemy dummy is now significant and positive, but the Enemies military spending variable is still insignificant.

Separating the sample into the Cold War and Post Cold War sub-samples, the Chow Test for structural stability proves utterly insignificant, with $F(14,176)= 0.47$, with $P(F>0.47)=0.94$. The predictive failure test (Chow's 2nd test) was also totally insignificant, with a probability value of 0.85.[24] Both tests remain completely insignificant if we eliminate insignificant variables from the regression. (GNP, US, USSR and Enemies military spending are individually and jointly insignificant.) Thus this exercise provides no evidence that there has been a change in the determinants of military burden between the two periods. However this conclusion must be taken as somewhat tentative, given the data incompatibility problems discussed above.

3.3.6 Structural stability within the samples

The above test was looking for a structural break over time, between the Cold War and Post Cold War periods. However it is also possible, given that we are dealing with a highly heterogeneous group of countries, that there are structural breaks between different subgroups of each sample.

[24] An F test found no significant difference between the variances of the two sub-samples, hence the Chow test is valid.

One possibility to look for is differences between the very high military spenders and the others. An interesting effect can be noted (see figure 1) when the dependant variable, log Military Burden, is plotted in ascending order. In the Cold War sample, the graph shows a sharp rise through the first 9 or 10, then a flattening off through the middle of the sample, and then another sharp upturn through the last 15-20. The pattern for the Post Cold War sample is similar. This suggests that the sample has a "Head" of countries with a very high military burden, much higher than the rest of the sample, and likewise a "tail" with very low military burden. Furthermore these extremes are not adequately explained by the regression for the whole sample.

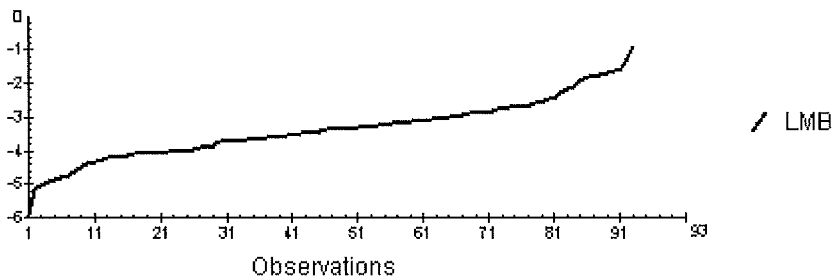
This suggests structural instability. A Chow test, using the first 76 observations for the Cold War estimation and the top 17 (chosen as the best estimate of the "Head"), produced a highly significant result, suggesting that the coefficients are not the same for the top 17. A CUSUM test on the whole Cold War sample shows the test statistic shooting rapidly above the upper 5% significance band as we move into the "Head"; this also suggests a systematic instability in the coefficients. Again the Post Cold War picture is similar.

There seems to be strong evidence therefore for the existence of the "Head"; a subgroup of around 17 countries who are very highly militarised, to an extent greater even than would be predicted from their particular circumstances as captured by the regression. A look at this group of 17 shows that 10 of them are in the Middle East (only 4 Middle East countries weren't in this group), and 7 of them were fighting an all-out war, whether internal or external, throughout the 1981-88 period. Iran and Iraq fall into both these categories. The remaining two countries in the Head are North Korea (whose figures are somewhat reduced in meaning in that ACDA estimate their military spending at a flat 20% of GNP) and, curiously, Mongolia. There were a few countries outside the Head (such as Peru) who were fighting all-out civil wars throughout the period, but none fighting external wars for any but a short period of time. Nonetheless, these war and regional factors have not in themselves adequately explained the high military burdens of the Head.

One hypothesis is that these countries have, for their various reasons, turned over so much of the state apparatus to the military that it has come to dominate, and can thus suck even more power and resources to itself, beyond what would be predicted from the behaviour of less extreme countries. But there is clearly great potential for exploring this.

The "Tail" is rather smaller, and cannot be so clearly established using the tests described above; looking at the data, there seem to be around 9 countries in the Cold War Tail; of these, 7 are also very low absolute military spenders, suggesting that what may be happening is that some countries scarcely bother with the military at all, and have no expectation of facing external threats with a military defence. Indeed, the military spending estimates for these countries is somewhat overstated, as it often includes internal security as is the case with Costa Rica who have no regular armed forces.

Figure 1: Plot of log Military Burden (LMB) for Cold War sample in ascending order.



3.3.7 Testing additional variables

The model estimated in Section 3.2 focuses heavily on threat variables. We consider here some additional variables that have been found to be significant by other studies, to see if they can be added to the model.

Rosh (1988) hypothesised that countries better integrated into the world economy would be able to find more sources of funds for arms purchases, and could thus have higher military spending. He proxied this variable by Imports + Exports per Capita. He actually found a negative and significant effect of this variable on military burden. One possible explanation would be that countries which trade widely with the rest of the world are less likely to adopt aggressive postures.

This was tested for by constructing a Trade variable (Imports + Exports) for each of the periods. However, whether using the raw trade variable (log transformed), or trade as a proportion of GNP, or trade per capita, it was not possible to find a significant result.[25] In fact the sign on any of the trade variables was positive, though insignificant.[26] Contrary to Rosh therefore, we do not find any significant effect of trade on military burden in this study.

It is also possible to consider geographical variables. Hewitt (1991) found that land area, length of land borders and length of coastline were all significant positive determinants of military spending. Incorporating these variables into the 1981-88 model (in log form,

[25] Unless the population variable was omitted. (Rosh did not use population).

[26] Trade per capita becoming significant with population omitted. One possible reason for this is that there is a substantial (-0.45) negative correlation between population and trade per capita; thus as population has a significant negative sign in the estimation, trade per capita would have a positive sign with population omitted. If trade per capita, income and population are all included, all three become insignificant (which is about the only way I've found of making population insignificant), though they are jointly highly significant, with population still having a negative sign and trade per capita positive. I don't see any particular relevance to this result,

using the Security Web data with China included). All three coefficients were positive, but only that on Coastlines was significant (10% level). However Area and Boundaries were jointly significant at the 10% level, and either was clearly significant with the other omitted. It is of course hardly surprising that land area and boundaries should crowd out each other's effect, as they are obviously correlated.

The inclusion of the geographical variables reduces the significance of the Security Web variable (even the improved one, including China's military spending) to 10%. It is possible that the effect is partly due to the fact that countries with large area and land boundaries, which therefore are likely to require more defending, will also tend to have lots of neighbours and thus high Security Web military spending. Thus this result weakens somewhat further the conclusion regarding the effect of non-hostile military spending. Nonetheless it is interesting that it is still possible to get distinct effects from the geographical and Security Web variables.

Including the geographical variables, along with the Security Web variables that included China's military spending, increased the R-bar squared of the Cold War model to 0.65.

3.4 Scale effects in the demand for military spending

Two interesting features of these results (in the cross-section model, but they are confirmed by the panel data study in the next chapter) are the negative coefficient on population, and the lack of a significant relationship between national income and military burden. This section first compares the results with other studies and then attempts to explain them both qualitatively and in terms of the model in section 3.1.1.

At least three other cross-country estimations look at these factors specifically: Hewitt (1991), Adams & Ciprut (1995), and Gonzalez & Mahey (1990).

For national income, Hewitt finds a quadratic relationship between GDP and military burden, with rising income initially increasing burden, then reducing it. Adams & Ciprut detect a negative relationship (in fact a coefficient of GDP per capita significantly less than one with military spending per capita as the dependant), while Gonzalez & Mahey fail to detect any significant relationship, as in the current study. (i.e. military spending does indeed seem to be proportional to GDP.) Hewitt's positive result may be partially explained by the fact that he does not include neighbours' military spending – as shown above, this can lead to a spurious positive income effect. The picture with population seems to be rather stronger: Hewitt finds no relationship, but Adams & Ciprut and Gonzales & Mahey both finding a negative relationship, in agreement with this study.[27]

We now consider the effect on military burden of three possible changes within a country, or differences between two countries. First, the effect of differences of national income, assuming the same population; second, the effect of differences in population, assuming the same income; and finally, the effect of simultaneous and proportionate changes or differences in both population and income, leaving income per capita constant.

3.4.1 Scale effects from greater GNP

We consider how the military spending decisions differ for two countries with the same population and facing similar security threats, but with differing levels of national income.

[27] (Actually Adams & Ciprut are a bit hard to interpret, as their main equation is (Log M – Log P) = 0.84(Log Y – Log P) – 0.39 Log P + … which rearranges to give (Log M – Log Y) = -0.16 Log Y – 0.23 Log P, but this involves combining two different standard errors to get the significance level for P – however the t-ratios for each component of the original equation are so large that the sign on Log P in the rearranged equation is almost certainly significant.)

Alternatively, we may consider the effect of an overnight significant increase in income for a country facing an otherwise unchanged situation. There are a number of possible ways to analyse this. On the one hand, countries may experience diminishing returns from defensive military efforts. One of the strongest and most constant aspects of military theory is that it is easier to defend than to attack. Thus once military spending reaches a level sufficient to prevent or deter attack from possible aggressors, it will offer diminishing returns. Of course one might want to continue to increase military spending to make absolutely certain that no-one will launch an attack, but the additional security value of such spending will be much diminished once a country can ensure, say, that no potential aggressor could enjoy a 2 to 1 advantage in military capacity. Thus one would expect that a higher-income country would need to spend a lower proportion of GNP than a lower-income country to achieve security. On the other hand, a state that wishes to project its influence beyond its borders, rather than simply deter attack, needs to spend very substantial sums on the military. Such power projection may involve the ability to intervene in regional conflicts, the ability to take punitive action against a neighbour that acts against its interests, the ability to exert pressure on a neighbour to act in a certain way, even the potential ability to invade and conquer a neighbour. (e.g. China-Taiwan). A small country cannot aspire to such a capability. Indeed one may argue that the ability to power-project is subject to increasing returns to military spending; the greater a country's superiority over its neighbours, the more profoundly it can influence and coerce them.

Thus while small countries may have a stronger incentive to devote a high share of resources to the military to deter attack, large countries may have an equally strong incentive to devote resources to the military to maximise their power and prestige in the region. Equivalently, "deterrence" may be seen as a "necessity", with a less-than-unity income elasticity, while "power projection" a "luxury", with a greater-than-unity elasticity. The fact that our results consistently show national income to be insignificant in the equation for military burden, equivalently that there is a unitary income elasticity of demand for military spending, suggests that these considerations are on average fairly evenly balanced.

Turning to the model of section 3.1.1, dividing equation (3) on p53 by Y, we have the following equation for military burden, $m=P_mM/Y$ (i.e. nominal military expenditure over nominal income):

$$(1) \qquad m = \alpha + \frac{(1-\alpha)P_mM_0P^r - \alpha C_0P_cP}{Y}$$

Note that $P_mM_0P^r$ is the minimum level of military spending, while C_0P_cP is the minimum level of civil expenditure. Differentiating gives

$$(2) \qquad \delta m/\delta Y = (1/Y^2)(\alpha C_0P_cP - (1-\alpha)P_mM_0P^r),$$

which could be either positive or negative. On the one hand, minimum civil expenditure (C_0P_cP) might be expected to be higher than minimum military expenditure ($P_mM_0P^r$) in most countries; on the other hand, the priority ratio α, that is the proportion of discretionary income that goes to the military, could generally be expected to be less than $1-\alpha$. What we could say is that if a country faces high levels of threat, proxied by M_0, but low levels of military ambition, proxied by α - in other words if military expenditure is essentially a necessity for this country – then we can expect a negative sign for the differential, whereas in the opposite case of low threat but high ambition, where military expenditure is a luxury, we can expect a positive sign, which is in line with the qualitative analysis.

3.4.2 Scale effects of population

Let us turn now to the effects of differing population, under similar security conditions and equal income. Again, it is possible to argue the case either way. On the one hand, countries with higher populations may have greater defence requirements. In the cross-section, a country with higher population probably also has higher land area and boundaries, etc., and thus has more to defend. This is not in proportion to the population; for example, assuming equal population density (and therefore area proportional to population), total boundary only increases with the square root of population. However, other things being equal, this may lead us to suppose that a country with higher population would need more military spending to achieve the same result; thus with unchanged income, this consideration would tend to cause military burden to increase with population, though almost certainly not proportionately. This argument may not apply, and certainly would apply with less force, when considering increasing population within a country. In direct opposition to this argument, a country with a high population, particularly if this population is spread over a wide area, is hard to control. Huge forces are required to control the area and to keep down the population. The possibilities of guerrilla movements are greatly enhanced. Attempts to invade and control Russia, for example, have been notoriously unsuccessful, even by very large military forces. Sheer size may be a factor in deterring a potential aggressor. Thus the extra defence requirements created by a larger population or land area are to some extent self-fulfilled, without requiring an increased level of expenditure.

A further consideration in favour of a positive impact may be that a high population will of itself make regional hegemony a more realistic possibility; to exert serious military influence on its neighbours, a country will require a large number of troops, almost however powerful its weaponry.[28] As we have argued that power projection is subject to increasing returns from military spending, a high population will move a country further along this curve of increasing returns, tending towards increasing military burden with population. However the availability of large numbers of troops presents an opposing argument: a country with high population may be able to place a greater reliance for its defence on relatively low-cost manpower, rather than on expensive weapons systems. Thus the same level of security can be achieved at lower cost by the populous country, which will tend to lower military spending.

These effects are to some extent speculative, and are in any event opposing. Together they give no clear indication of the sign we would expect on population in determining military burden. Indeed one might conclude that these effects cancel out. However one further effect is, in the view of the author, decisive: while security requirements rise less than in proportion to population, civilian needs will tend to rise more or less in proportion; certainly consumption requirements, health, education, etc. (There may be some economies of scale in publicly provided services, but the case is not clear). Thus as population rises (with income constant), the civil demands of the population are more pressing than those of security, and thus we would expect military spending clearly to go down. This is one way of explaining the negative sign on population in this and other studies.

This comes out to some extent also from the model of section 3.1.1. Differentiating equation (1) above gives

(3) $$\delta m/\delta P = (1/Y)\ (r(1-\alpha)P_m M_0 P^{r-1} - \alpha P_c C_0)$$

[28] Conceivably the most advanced US weapons may negate this; the debate over whether air power alone

Clearly if r=0, that is if defence is a pure public good, then $\delta m/\delta P$ is negative. If r s between 0 and 1, the picture is not so clear; note that $P_m M_0 P^{r-1}$ and $P_c C_0$ are now minimum military and civil expenditure per capita respectively, so that again we would expect the first to be smaller than the second in most cases. On the other hand, we would still expect $1-\alpha$ to be less than α. However we also have r<1, so this may suggest a negative sign in most cases, particularly if military expenditure is seen as a largely public good. Also note that as P increases, the sign of $\delta m/\delta P$ must eventually become negative.

3.4.3: Effects of an overall change in scale

A further scenario to consider is where income and population rise in proportion, leaving per capita income unchanged. Given the clear negative coefficient on population and the insignificant (though in fact negative) coefficient on income in both the cross-section and the panel data, our equations would seem to predict a fall in military burden. Does this make sense in terms of the above analysis?

Thus suppose that a country becomes larger, with population and income increasing in proportion. (We might even, counterfactually, suppose a proportionate increase in area). Let us first suppose that the enlarged country leaves the distribution of resources unchanged, including the military burden. What has changed? Looking at the civilian side, per capita consumption and investment spending has remained constant, so this aspect of welfare is more or less unchanged. On the other hand, absolute military spending has gone up considerably. The amount to be defended has also gone up (borders, coastlines, etc.), but as we have argued, not in proportion to population. Thus there has been a considerable increase in security.

won the day in Kosovo is as yet unresolved, but for developing countries the above claim clearly holds.

In sum, this country and its people enjoy a higher level of welfare than before, but the improvement has all been taken in the form of security. On the other hand, a lower level of military burden (though a higher level of absolute military spending), would achieve the same level of security but a higher level of civil welfare. Without going into the mathematical details, most models would predict that the optimising level of military spending would lie somewhere between these two points, with the welfare gain distributed between the civil and security sectors. Thus the higher population and income should lead to a lower military burden.

This actually comes out very clearly from the model. Letting y=Y/P, income per capita, we may rewrite equation (1) above as

$$(4) \qquad m = (1/y)\,((1-\alpha)P_m M_0 P^{r-1} - \alpha P_c C_0),$$

whence since r<1, if we leave y constant but increase P (and Y), it is clear that m decreases.

In the end we are left with an argument along the lines of "economies of scale"; the key point being that defence enjoys economies of scale relative to civil spending, when considering increasing population. With regard to national income, there are arguments in both directions, so the lack of a clear empirical result is not surprising.

3.5 Conclusions

Using a utility maximisation model as a broad theoretical starting point, we have estimated military burden across developing countries as a function of income, population, various threat variables, and a political variable (democracy). This has been carried out for two separate periods, one during the Cold War from 1981-1988, the other immediately following the end of it (1990-97), with data for each country averaged over the 8-year period in question. In each case the results bear out the initial premise. Military expenditure is found to be roughly proportional to income (equivalently, income is insignificant in determining military burden), and to increase according to various measures of threat used. In particular, Rosh's result is confirmed, that military burden is positively influenced by the overall level of military spending in a country's "Security Web". However this study has added some nuances to Rosh's conclusions: Firstly, we find that it is the absolute level of military spending in the Security Web that is significant, rather than the average military burden; secondly, we see that it is military spending by hostile or potentially hostile neighbours that has the greatest influence, and indeed the effect of the general level of neighbours' military spending cannot be distinguished from their economic size.

As would be expected war, both internal and external leads to increased military spending. However even accounting for effects of war and military expenditure by neighbours and rivals, the Middle East and, to a lesser extent, South East Asia, have higher military burdens than would otherwise be predicted. In common with other studies, we have found that more democratic countries tend to spend less on the military. Also in common with a number of other studies, we have found that more populous nations tend to have lower military burdens. This could be explained from a number of theoretical standpoints, though it is argued here that countries with high populations will, other things being equal, have proportionately higher need for civilian expenditure, but less than proportionately higher security needs.

Overall, these regressions have been fairly successful in explaining differing levels of military burden across developing countries, with the best models explaining between 60-70% of the variation.

One of the aims of this study was to ascertain whether the relative importance of internal and external factors for determining military spending has changed since the end of the Cold War. The evidence from these results is very tentative. The most dramatic finding is the insignificance of External War. This is more a reflection of the fact that there are now very few all-out interstate wars than that such events do not generate huge amounts of military spending.[29]

Although External War is not detectable as a driver of military spending post-Cold War (at least in the cross-section), the preparation for such very much is. The impact of neighbour's military spending, hostile or otherwise, and the effects of regional circumstances are still significant, though it is possible that the levels of significance have dropped. One mildly interesting feature is that Great Power Enemy status begins to show up (if one leaves out the Enemies' Military spending variable with which it is correlated). With only one superpower, enmity with that superpower (which this variable largely reflects) means a nation can only look to its own resources against such a dangerous opponent!

Looking at other variables, those relating to external threat (neighbours' and rivals' military spending and regional effects) mostly remain significant, but with lower coefficients and t-ratios in the later period, which may suggest that these factors have

[29] Looking at the actual years of those wars that did take place, Iraq's military burden was over 60% in 1990; Kuwait's was over 50% in 1990, over 100% in 1991 (which is explained by the huge amounts of military aid given) and 77% in 1992. Azerbaijan's military burden dropped sharply after the cease-fire in the war with Armenia, and Vietnam's likewise after their withdrawal from Cambodia. However the brief Peru-Ecuador war did not seem to have a major impact on either side's military burden.

become relatively less important. However an attempt to assess this statistically, through a structural stability test on a combined sample of both periods, failed to find a significant result, leading to the tentative conclusion that the patterns of demand for military spending in developing countries have not greatly changed since the end of the Cold War. Due to the data incompatibility problems for this combined sample though, it is not possible to reach a firm conclusion.

Of the other two main research questions specified in section 3.1, the first would seem to have an ambiguous answer, the second a clear positive one. Firstly, there is evidence that the general level of military spending in the Security Web, even by non-hostile nations, is important; but it is not possible to distinguish this from the economic size of these nations. We cannot therefore conclude, for example, whether large-scale arms deliveries to a country not especially caught up in regional conflict or serious tension, could provoke arms races amongst neighbouring countries. On the other hand where there is a history of hostility between countries, even one short of all-out war, there is very clear evidence of positive mutual influences between these countries' military spending.

These results relate only to differences between countries, from cross-section analysis. They cannot necessarily be extended to the dynamics of military expenditure over time. To do so, we shall need further evidence from panel data and/or case studies. This shall be attempted in the following chapters.

Chapter 4: A panel data model for the demand for military expenditure.

In the previous chapter, we estimated cross-section models for the demand for military expenditure during and after the Cold War. This tells us a lot about the differences in military burden between countries, but gives no information about the dynamics of the process. It is possible that the way military expenditure responds to changes in variables over time is quite different to the way in which these variables are correlated with military expenditure across countries.

One way of understanding the dynamics of military expenditure is to look at case studies of individual countries, as we do in the next two chapters. However another approach that allows us a much more general understanding of the process in question is the use of panel data. This incorporates both cross-section and time-series information, by pooling the time series for the different countries in the sample. In this chapter, we use the same dataset as before to estimate a panel data model of the determinants of military spending for the period 1981-1997, using as many countries as possible from the previous two samples. This exercise will give us an understanding of the within-countries dimension of demand for military expenditure, complementing the between-countries picture we obtained in the previous chapter. One point of interest will be to compare the two to see if the same factors are significant. There is no a priori reason to assume that they will be, as cross-section and time series data may be measuring different things.[30]

In the first section, we discuss briefly some of the econometric issues relating to panel data, leading to a choice of a suitable set of panel estimators. In section 2 we describe the

[30] For example, we have seen in the previous chapter that countries with higher populations tend to have smaller military burdens. Does this mean that as a country's population rises, its military burden can be expected to fall? This is an entirely separate question. The population effect of the last chapter may simply reflect a difference between the strategic position of large and small countries – a status that does not significantly change over a country's lifetime. The effect of a rising or falling population over time may be entirely different, for example reflecting changing economic priorities.

dataset that resulted from merging the Cold War and Post Cold War samples into a cross-section/time series pool, and section 3 presents the regression results. In section 4 we again try to ascertain if there has been a structural break in the model since the end of the Cold War. In section 5 we break the panel down into four regional panels, to see if there are regional variations in the demand for military spending. Section 6 concludes.

4.1 Econometric issues in the choice of panel data models

One of the major problems with panel data is deciding which model is most appropriate. The simplest model is simply to treat each country-year as a completely separate observation, giving the model (in the case of two variables):

$$Y_{it} = \alpha + \beta X_{it} + e_{it} \qquad (1)$$

Where the index 'i' runs from 1 to N and represents the country, and 't' runs from 1 to T, representing the year. The error term e_{it} is the usual normally distributed white noise residual, with variance σ^2.

The problem with this is that it takes no account of the fact that observations for a particular country will be linked by the peculiar circumstances of that country. The estimates obtained will be inaccurate. What is more, it is likely that the strong cross-sectional variation that we know exists in this case will swamp the time-series effects, yielding little or no new information.

When we have a long, narrow panel (i.e. few groups, many time periods), models can be used which correct for effects such as cross-group heteroskedasticity and within-group serial correlation. Greene (2000) describes some of these techniques. However that is probably not best suited to the panel here, which is only moderately long (17 periods), and very broad.

With such panels, the most commonly used models are the Fixed Effects and Random Effects models. The Fixed Effects model (FEM) essentially includes dummy variables for each group, giving the model:

$$Y_{it} = \alpha_i + \beta X_{it} + e_{it} \qquad (2)$$

The α_i terms are the 'fixed effect' terms, the specific effects for each country. This has the effect of "factoring out" the cross-sectional variation in the variables, leaving only the effect of variation of the regressors on the dependant variable within each group. It is thus known as the "within-groups" estimator.[31] Potential disadvantages include the fact that the estimates for the group dummy variable coefficients are inconsistent, and the fact that the cross-section effects are not picked up by the FEM. In particular, variables such as the Middle East dummy that do not change in time cannot be used at all. On the other hand, the fact that the individual country effects may well be highly correlated with the regressors does not affect the consistency of the estimators.

The Random Effects model assumes that the dependant variable is determined by the regressors, the usual stochastic term, and an additional stochastic term which is particular to each group:

$$Y_{it} = \alpha + \beta X_{it} + u_i + e_{it} \qquad (3)$$

[31] An equivalent formulation of the model is to transform each variable by taking the difference of each observation from its group mean, and then performing a pooled regression – thus any relationship that may exist between the group means, which is what was estimated in the previous chapter, is factored out.

Where $u_i \sim N(0,\tau^2)$ represents the random group effects.

The model tends to be most appropriate when the groups in the sample are randomly selected from a large population (Baltagi 2001) (e.g. a sample of individuals from a workforce).[32] One problem with the Random Effects Model (REM) is that it requires that the u_i are independent from the regressors, the X_{it} (Baltagi 2001). In our case this is unlikely, as we know that there are substantial cross-country effects of the regressors on the dependant variable. In practice, the effect of the REM is frequently somewhere between the FEM and the simple pooled model with each observation treated independently. (Smith & Dunne, 2002)

From our point of view, therefore, the FEM seems more suitable, as it allows the regressors to be correlated with the individual country effects. It also provides a natural complement to the cross-section model of the previous chapter; where that gave us 'between groups' estimators, the FEM gives 'within groups' estimators of the coefficients.[33]

A problem with either the Fixed or the Random Effects Model is that they assume parameter homogeneity, namely that the values of β for each regressor are the same for all groups. This assumption is generally rejected when tested. (Smith, 2000). An alternative is the Random Coefficients Model (RCM), which assumes that the coefficients of each regressor vary across groups, according to a stochastic distribution. However, this is very difficult to estimate in this particular context, as firstly it tends to need a long panel in time, and secondly it requires that all the independent variables are non-colinear in each

[32] In this case, the true 'population' from which the individuals are selected can be seen as the set of all possible circumstances and decisions involving each individual, rather than simply the set of all individuals. Thus the individual effects terms, the u_i, can reasonably be characterised as random.

[33] In fact, the Limdep econometric package used in this study provides a Hausmann specification test (Limdep manual) between the FEM and REM, which did indeed strongly prefer the FEM.

group; whereas in our dataset, many countries have Security Web and/or Potential Enemies military spending of zero throughout the period, and indeed most countries have External War equal to zero throughout.

Furthermore, there are circumstances in which the FEM can give a consistent estimate of the average β's, even under the assumption of the RCM. In particular, Smith (2000), quoting Phillips & Moon (1999), states that where a FEM is used for I(1) variables under the assumption that the actual parameters are random across groups, the estimated coefficients are consistent (as $N \rightarrow \infty$) estimators of the long-run average coefficients: that is, the ratio of the average across groups of the long-run covariance between the dependant and independent variable, to the average across groups of the long-run variance of the independent variable. (Smith 2000). This is because, even though the levels regression for each group could be spurious for I(1) variables, the 'noise' that generates these spurious regressions can be expected to average out over all the groups. It is not unreasonable to believe that in this case, most of the variables used, for most of the countries, are likely to be I(1). While the time series are too short for conventional tests of stationarity to be useable, variables such as national income, military expenditure, population etc. are almost always found to be integrated[34]. If we consider a variable such as Democracy or Great Power Enemy, we may also reasonably expect this to be 'persistent', i.e. integrated, rather than tending to revert towards a long-term mean. Therefore we have reason to believe that the estimates provided by the FEM convey meaningful information, despite the potential problem of parameter heterogeneity.

[34] E.g. Gerace (1999) finds military spending series for all of India, Pakistan, Greece, Turkey, the US, the USSR, Israel, Egypt, Syria, Iran and Iraq to be I(1). Population can be argued to be at least I(1) by its very nature, as this year's population is equal to last year's plus births – deaths. The democracy variable taken from the Polity 98 dataset was tested for stationarity using the ADF test for a number of developing countries; all but one accepted the null of a unit root, even though many of these data series stretched back over 150 years; Dunne, Nikolaidou & Smith (2000) comment that many series that appear I(1) over short periods are found to be I(0) over longer periods.

Difficulties occur in panel data models if we attempt to incorporate dynamics, for example a lagged dependant variable. In the Fixed Effects Model, lagged dependant variable bias means that the estimators of both the lagged dependant variable and the other regressors are biased. Furthermore, because this bias relates to the initial conditions in each group, this bias does not disappear as $N \rightarrow \infty$ - in other words the estimators are inconsistent. Worse, if the assumption of parameter homogeneity, namely that the βэσ are the same for each country, is incorrect, then the Fixed Effects estimator gives an inconsistent estimate of the average β's, even for large T (Smith, 2000). These problems can be overcome by the use of dynamic panel techniques using instrumental variables (Baltagi, 2001), which is an avenue for further research. However in this study we shall not include a lagged dependant variable in our estimations.

4.2 Description of data

Estimating a Fixed Effects model does not require a balanced panel, i.e. one with the same number of observations in each group. Hence a country was included in the combined sample if data was available for at least eight of the seventeen years from 1981-1997.[35] This allowed 98 countries to be included in the sample, with a total of 1525 observations.

As discussed in the previous chapter, combining the two datasets involves the problem that ACDA have re-estimated the military spending data (and sometimes also income data) from one period to the next, and in a manner giving highly divergent results both across and within countries. In the second dataset, when referring to overlapping years, some countries' military spending estimates have been revised consistently upwards, some

[35] Data for 1989 was included in the sample, along with the 1981-88 and 1990-97 datasets previously used. States of the former Soviet Union for example clearly could not be included as they were only independent from 1992. The united Yemen formed in 1990 was treated as the successor state to North Yemen, while South Yemen was treated as ceasing to exist. Countries excluded from the sample could nonetheless form part of the Security Web of other countries that were included.

consistently downwards. Others have been revised upwards in some years and downwards in others. Indeed it is not that unusual even for the direction of movement to change as a result of the revised estimates in some years. It is conceivable this could produce spurious results; it is more likely that it will make it difficult to obtain significant t-ratios.

There are some differences between the datasets used here compared to the previous chapter. In particular, the Security Web totals were calculated with China's military spending included in the totals for countries in the region, as this seemed indicated by the cross-section results. Some variables that do not vary across time, such as regional dummies, were not used. In addition, Enemies military spending and Unquantified Threat, which were never significant in the cross-section, are not used here. However the Trade variable (total imports plus exports), which was considered as a possible additional variable in the last chapter, was included from the start in this case.

Figure 1 below plots the average military burden of the sample from 1981 to 1997. Figure 2 plots the average totals for Security Web military spending and Potential Enemies military spending, while Figure 3 plots the average "hostility coefficient", the ratio of Potential Enemies to Security Web. These graphs provide an interesting picture of the changing security environment facing countries in the sample. We see that the average military burden of the sample peaks in 1983, then follows a downward trend (with an upward blip in 1990, due to Iraq's invasion of Kuwait), flattening out after 1993. The average Security Web total does not change so much (as it measures absolute military spending rather than military spending/GNP). The particularly large blip in 1990 is due to Iraq entering the Security Web of several extra countries in that year, again due to the invasion of Kuwait. The "Hostility coefficient" rises gradually through the 1980s, then drops sharply following the end of the Cold War, followed by a more gradual fall through the mid 1990s, and an upturn in 1997. This is a graphic illustration of how the end of the

Cold War affected the security environment of many countries not directly involved in the superpower confrontation.

Figure 1

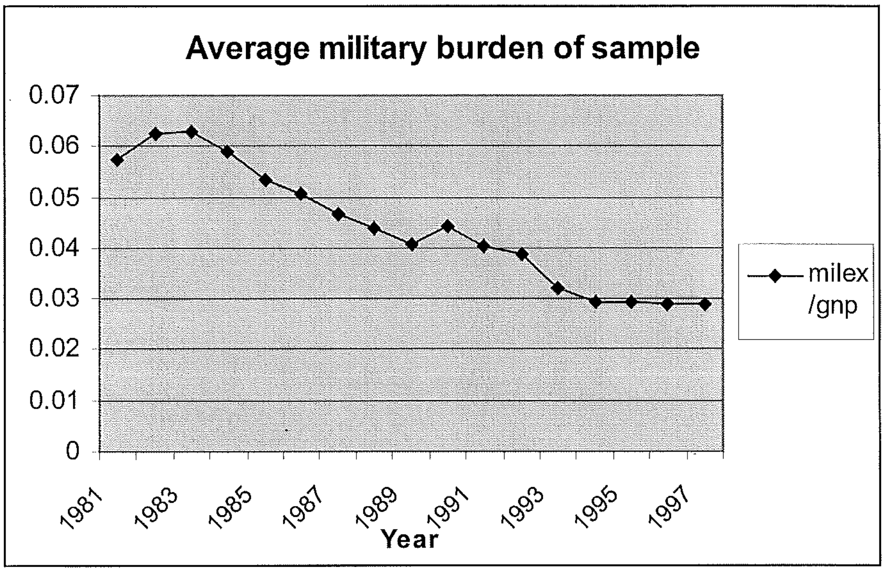


Figure 2 Average military spending of Security Web and Potential Enemies

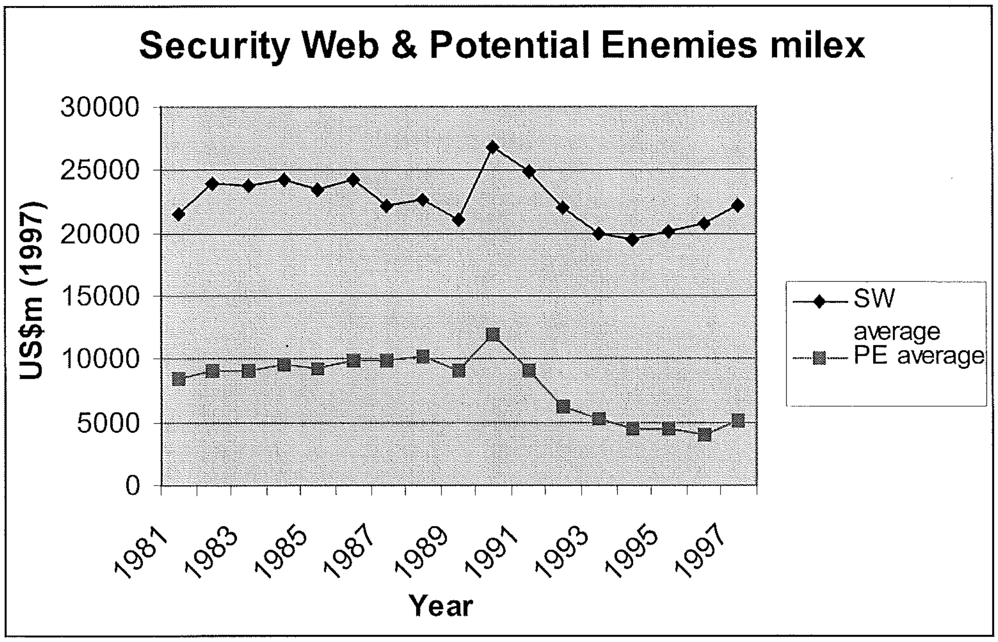
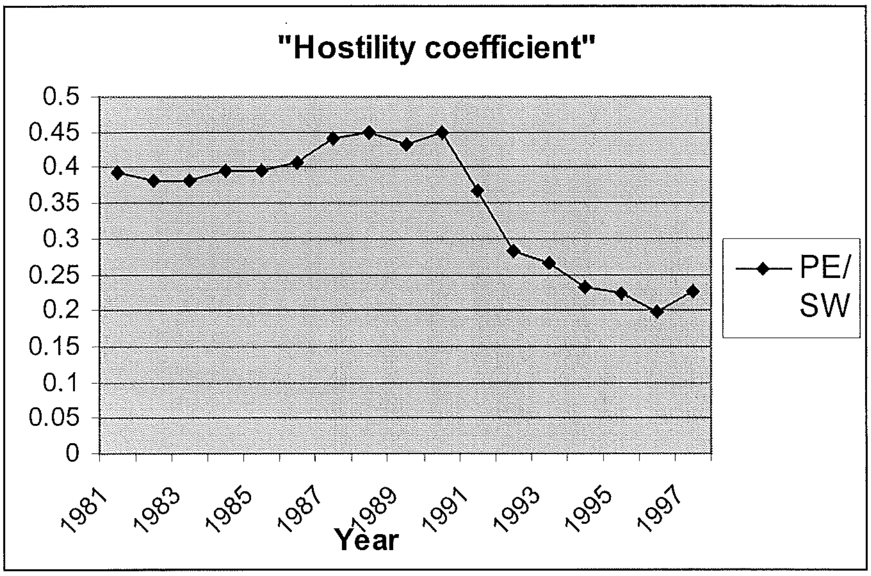


Figure 3: Hostility coefficient



4.3 Regression results

Using a Fixed Effects model, log military burden was regressed on External War, Civil War, Great Power Enemy, Democracy, log GNP, log population, log trade, log Security Web military spending and log Potential Enemies military spending (which as before includes Enemies); as a negative (though insignificant) coefficient was obtained for log Security Web military spending, which as well as being contrary to expectations creates problems of interpretation, alternative models were used using log "Others" military spending (i.e. those not in the Potential Enemies or Enemies category) in place of the total Security Web figure. This removes the problem in the first model, whereby Potential Enemies is a subcategory of Security Web, but with the two variables having opposite signs.

The results, together with model statistics, are given in Table 1 below. The main difference between the models is that while in both models, the coefficient of log Potential Enemies military spending is positive and highly significant, in model 1 the coefficient of log Security Web military spending (including Potential Enemies) is negative (though insignificant), whereas in model 2, the coefficient of log Others military spending (thus not including Potential Enemies) is positive and significant. While the effect of Potential Enemies military spending seems fairly unambiguous, these results are difficult to interpret in terms of the effects of military expenditure by non-hostile neighbours[36]. As we can see from the model statistics there is essentially nothing to choose between the two specifications in terms of goodness of fit.

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

Table 1 Regression results for Fixed Effects Model

Dependant variable is log military burden

	Model 1		Model 2	
Variable	Coefficient	t-ratio	Coefficient	t-ratio
External War	0.60***	8.8	0.60***	8.8
Civil War	0.11***	9.4	0.11***	9.4
Great Power Enemy	0.089	1.0	0.12	1.4
Democracy	-0.014***	-5.5	-0.014***	-5.6
log Population	-0.33***	-4.9	-0.31***	-4.7
log Trade	-0.036*	-1.9	-0.043**	-2.2
log GNP	-0.000	-0.0	-0.011	-0.3
log Security Web milex	-0.027	-1.5		
log Potential Enemies milex	0.041***	7.9	0.044***	8.0
log Others military spending			0.032**	2.4
Number of observations	1508		1508	
R-bar squared	.86		.86	
Standard Error	.34		.34	
Log Likelihood	-453		-451	
Estimated (time) autocorrelation of residuals	.67		.67	

Overall the results are reasonably encouraging. Strong results are obtained as before, sometimes stronger than in the cross-section models, for External War, Civil War and Potential Enemies (positive) and for Democracy and Population (negative). Given the fact that the Civil War variable goes from 0-4 while External War goes from 0-1, these coefficients are roughly comparable[37]. Log trade has a significant and negative coefficient, supporting Rosh (1988)'s findings, though the variable is barely significant in the first model. Great Power Enemy is positive as expected, though insignificant. Income remains clearly insignificant, suggesting a unitary income elasticity of demand over time, as well as across countries. With regards the population effect, the argument of section 3.4 seems to be supported. The sort of population changes experienced over a seventeen year period would hardly be likely to change a nation's strategic outlook one way or the other; what would be significant is that a growing population would, other things being equal, create higher demand for civilian goods and services, while having at most a marginal effects on security perceptions. Thus, military burden would be expected to fall. Again, we see that this result holds whether or not GNP is also included in the equation.

The greatest difficulty comes in interpreting the results for the coefficients on log Security Web or log Others military spending - and inter-linked with that, log Potential Enemies military spending. On the one hand it seems clear that an increase in total military spending by hostile neighbours is strongly associated with an increase in military burden. However even this result fails to distinguish between two potentially very different effects: on the one hand, a change in military spending by a hostile power; on the other hand, a change in status of a power between hostile and non-hostile. Both of these would lead to changes in the Potential Enemies military spending total. It is conceivable that this is related to the curious result whereby log Security Web has a negative, but log Others a positive (though insignificant) sign in the respective models.[38] Overall, while the result for Potential Enemies is strong, it is not possible to draw any conclusions from these results regarding the effect of variations in military spending by non-hostile neighbours. This is not so different from what is suggested by the cross-section picture: a strong relationship with Potential Enemies military spending, but only a weak one with general Security Web military spending, which could equally well be explained in terms of the overall economic size of neighbouring powers.

Oren (1994) suggests, with empirical support, that in the context of the India-Pakistan rivalry, it is changes in the level of hostility rather than the rival's military spending, that leads each country to vary their own military spending. Each country's military burden increases in response to belligerent acts by the other, but Oren actually finds negative coefficients on changes in the rival's military spending.

It would, therefore, be helpful to distinguish between the effects of changes in the Potential Enemies military spending total resulting from changes in spending and changes in levels of hostility, that is, of countries becoming or ceasing to be Potential Enemies. As noted above, the positive coefficient on Potential enemies military spending does not in itself make this distinction.

One way of doing this is to use the Hostility variable, defined as the ratio of Potential Enemies to Security Web military spending, or zero where a country has an empty Security Web. Other things being equal, a given change in the Potential Enemies total resulting from a change in hostility would have a much greater impact on the hostility ratio

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

[38] For example, in the specification with Security Web, if a hostile relationship ends for example, there is a drop in the PE total, but no change in the SW variable. In the Others specification, there is a drop in the PE total again, but a *possibly quite substantial* rise in the log Others total, as log changes most rapidly at low values. However it is not clear whether this explains this particular combination of coefficients.

than the same change resulting from changes in spending by countries in the Potential Enemies category. Log military burden was thus regressed on External and Civil War, Democracy, Great Power Enemy, log Population, log Trade, log Potential Enemies military spending, and the Hostility ratio (leaving out the insignificant income variable, and the ambiguous Security Web/Others variables.) The result that while the coefficient of log Potential Enemies was still highly significant and positive, the coefficient on the Hostility ratio was actually significant and negative. This suggests that changes in military expenditure by existing hostile powers are indeed significant, indeed that dollar for dollar, this has a greater effect than the acquisition of new enemies. The result is unaffected by the inclusion of log Security Web or log Others in the regression.

4.4 The end of the Cold War

In the cross-section study, little evidence was detected of different patterns of demand between the Cold War and Post Cold War periods. However, this only relates to the differences between countries, and as discussed before, the processes within countries may be of a different nature. It is interesting to test for a change in the determinants of military spending using the panel data model.

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

We start by dividing each country into two periods: 1981-1989, and 1990-1997. Before we can apply standard tests for changes in the parameters, we must check whether the variances for the two samples are the same. If they are not, we will have to use GLS methods. To test for this, two separate FEM regressions are run[39], and the estimated σ^2 values are retained from each. These are 0.238 and 0.256 for the Cold War and Post Cold War periods respectively, with 658 and 635 degrees of freedom respectively. This gives $F(644,668)=0.256/0.238 = 1.076$, which is insignificant even at the 10% level. We may thus accept the null hypothesis that the variances are the same for the two periods.

We may thus validly use standard hypothesis tests to test for a structural break after 1989. There are two ways in which we may do this: on the one hand, we may assume that the individual country effects are the same for both periods, and test for equality of the coefficients on the regressors; on the other hand, we may assume different intercepts between the periods, and again test the model with equal slopes against the one with different slopes in the two periods. A further approach is to compare all four possible models (changed/unchanged country effects combined with changed/unchanged slopes) using a model selection criterion such as the Schwarz-Bayesian Criterion.

First we test the original model, with the same group effects and slopes for both periods, against a model with the same group effects, but different slope coefficients over the two periods. We do this by introducing slope dummies for each of the independent variables, equal to the variable multiplied by a dummy variable D equal to 0 for 1981-89 and equal

[39] All the regressions for these tests use the same list of independent variables: log Population, log GDP, log Security Web military spending, log Potential Enemies military spending, External War, Civil War, log Trade and Democracy.

to 1 for 1990-97. Thus if we have dependent variable Y, independent variable X, we have an equation:

$$Y_{it} = \alpha_i + \beta_1 X_{it} + \beta_2 D_t + \beta_3 D_t X_{it} + \varepsilon_{it}$$

Which breaks down into two separate equations. For 1981-1989 (when D=0), we have

$$Y_{it} = \alpha_i + \beta_1 X_{it} + \varepsilon_{it}$$

While for 1990-1997, when D=1 we have

$$Y_{it} = \beta_2 + \alpha_i + (\beta 1+\beta 3) X_{it} + \varepsilon_{it}$$

Thus we are allowing a change in the slope of each independent variable, and a global change in the mean. We are not however allowing the fixed effects coefficients for each country to change.

The results are given in Table 2 below. We see that, while the period dummy (POST) itself is clearly insignificant, there are highly significant coefficients on the slope dummies for Civil War and Population. The effect of Civil War in the later period is significantly greater, with a total coefficient of 0.134 instead of 0.082 – over 70% higher. The negative population effect is also significantly stronger, with a total coefficient of –0.337 instead of –0.285. The slope dummies for log GNP and Great Power Enemy are also slightly significant, at the 10% level. In the case of Great Power Enemy this would not seem to mean much, as the two coefficients are working in opposite directions, and the Great Power Enemy coefficient itself is not significant.

The slope dummies (and period dummy) are jointly very highly significant: An F-test of the joint zero restrictions of these variables gives $F(9,1393)=3.38$, which is significant at the 0.1% level of significance. Thus the hypothesis that the coefficients of the regressors are the same is strongly rejected. As in particular the results showed an enhanced effect of Civil War in the Post Cold War period, this gives some support to the hypothesis that internal factors have become more important relative to external factors since the end of the Cold War.

Table 2: Regression with slope dummies for Post Cold War period.

Dependant variable is log military burden, 1508 observations.

Variable	Coefficient	T ratio
External War	0.479***	6.0
Civil War	0.079***	5.6
Great Power Enemy (GPE)	0.105	1.2
Democracy	-0.011***	-3.4
log GNP	0.042	1.0
log Population	-0.271***	-3.2
log Trade	-0.020	-0.9
log Security Web milex	-0.024	-1.3
log Potential Enemies milex	0.041***	6.5
POST dummy	-0.115	-0.9
POST*LGNP	0.065	1.7
POST*EW	0.113	0.9
POST*CW	0.056***	3.8
POST*DEM	-0.005	-1.5
POST*LPOP	-0.081***	-3.7
POST*LT	-0.036	-1.2
POST*LPE	-0.005	-0.8
POST*GPE	-0.161	-1.7
POST*LSW	-0.008	-0.9

We now test for a change in the coefficients on the regressors, allowing the intercepts to vary. Our restricted model therefore has different intercepts in each period, but the same slopes:

$$Y_{it} = \alpha_{1i} + \beta X_{it} + \varepsilon_{it} \text{ (Cold War)}$$

$$Y_{it} = \alpha_{2i} + \beta X_{it} + \varepsilon_{it} \text{ (Post Cold War)}$$

This model is estimated by re-stratifying the sample, breaking the observations for each country into two separate groups, one for the Cold War observations and one for the Post Cold War observations, then running a single FEM estimation on this re-stratified panel; thus for each country, there is one group effects dummy for the Cold War period, and another for the post Cold War period, but only a single set of slope coefficients for the regressors.

The unrestricted model allows both the intercepts and the slopes to be different in each period. This simply amounts to two separate Fixed Effects regressions, one for each period:

$$Y_{it} = \alpha_{1i} + \beta_1 X_{it} + \varepsilon_{it} \text{ (Cold War)}$$

$$Y_{it} = \alpha_{2i} + \beta_2 X_{it} + \varepsilon_{it} \text{ (Post Cold War)}$$

Table 3 below presents the results for the restricted model, while Table 4 presents the results for the two separate regressions for the two periods. For the most part, the results are similar to the original model, with positive coefficients on the war variables and Potential Enemies, and negative coefficients on democracy and population. However we now have a significant negative coefficient on log GNP, a clearly positive and significant coefficient on Great Power Enemy, and a marginally positive, though insignificant coefficient on Security Web. The RSS is 85.0, much lower than in the model with a single country dummy, and the adjusted R^2 is 0.918, likewise considerably higher.

Moving onto the separate regressions, the Cold War results above are somewhat curious, with only three variables, GDP, Civil War and Potential Enemies clearly significant, with a negative coefficient on Civil War. The Post Cold War results are more like the overall results, though Potential Enemies is no longer significant. Democracy is barely significant in the Post Cold War model, and insignificant in the Cold War model. These results are somewhat disappointing, but this may be due to the shortness of the two separate panels; the FEM only picks up variations in the variables within each country over time, so we may be finding that there has been insufficient variation within each period in many countries for effects to be detectable. Over the full 17-year period however, the variables have a chance to vary enough to give meaningful results.[40] The adjusted R^2 for the Cold War regression is 0.935, and for the Post Cold War, 0.908.

We now test between these two models. The Residual Sums of Squares for the Cold War and post Cold War regressions are 37.3 and 41.7 respectively, with 659 and 635 degrees of freedom, giving a total RSS of 79.0 for the unrestricted model, with 1294 degrees of freedom. The RSS for the restricted model was 85.0, with Performing an F-test to compare the models, we obtain $F(9,1294)=((85-79)/9)/(79/1294)=10.9$, which is highly significant.

To examine the hypothesis that internal factors have become more important in the second period, we need to know which individual slope coefficients are significantly different

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

over the periods. To do this we can run the last pair of regressions as a single regression with overall slope coefficients and slope dummies for the Post Cold War period, again stratified into country-periods. This of course is merely a re-arrangement of the equations, and gives the same RSS etc. When this is done the slope dummies are significant for External War, Civil War, Great Power Enemy, log Trade and log population, which is a larger group than the model with constant country dummies, where only Civil War and log population had significant slope dummies. It is not easy to draw clear conclusions as to the meaning of these changes.

Table 3 Fixed Effects Model for panel re-stratified by country-period

Dependant variable is log military burden, 1508 observations

Variable	Coefficient	T-ratio
External War	0.276***	4.2
Civil War	0.049***	4.2
GPE	0.848***	5.6
Democracy	-0.006**	-2.4
log POP	-0.192**	-2.3
log Trade	0.005	0.2
log GNP	-0.203***	-4.1
log SW milex	0.029	1.4
log PE milex	0.023***	3.8

Table 4: Separate Cold War and Post Cold War regressions.

Dependant variable is log military burden. 766 observations for Cold War period, 742 for Post Cold War.

	Cold War		Post Cold War	
Variable	Coefficient	T ratio	Coefficient	T ratio
External War	0.051	0.6	0.576***	5.8
Civil War	-0.033*	-1.9	0.108***	7.1
GPE	0.216	1.0	1.036***	5.1
Democracy	-0.004	-1.1	-0.007*	-1.8
log POP	-0.060	-0.7	-1.024***	-4.6
log Trade	-0.015	-0.6	0.157***	2.8
log GNP	-0.173***	-3.3	-0.189	-1.5
log SW milex	0.029	1.4	0.011	0.2
log PE milex	0.021**	2.6	0.015*	1.6

Given the very large overall size of the samples, possibly a more appropriate way to compare all four models is using the Schwarz-Bayesian Criterion, which in such cases penalises over-parameterisation more heavily. This criterion is given by:

SBC = Maximised Log Likelihood – Number of Parameters * Ln (Total Observations)/2

This gives the following results, shown here in Table 5:

Table 5: Schwarz-Bayesian criterion for different structural break models between Col d War and Post Cold War periods.

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

Thus the last model, with two entirely separate regressions for the two periods, is preferred by the Schwarz-Bayesian Criterion. Overall therefore, these results give strong evidence that there has been a change in the pattern of demand for military spending since the end of the Cold War; however it is not easy to interpret the nature of this change, and the significance of this may be reduced by the shortness of the panels for the two separate periods.

4.5 Regional variations

Up to now we have assumed homogeneity of parameters across countries in our model. As discussed, even if this is not the case the Fixed Effects Model should give a meaningful and consistent estimate of the long-run average coefficient. However we may be able to get a richer set of results by breaking our sample down into at least slightly more homogenous regional groups. Maizels and Nissanke (1986) for example found quite different results for different regions in their cross-sectional analysis of the demand for military spending. Our sample size is sufficient that it is feasible to split it up into regions, which was not entirely viable for the cross-sections model. Four regions were used:

- Western Hemisphere: South America, Central America and the Caribbean

- Africa: The continent of Africa excepting Egypt
- The Middle East: Where the land borders of this region are defined to include Turkey, Iran and Egypt.
- Asia: All of Asia excluding the Middle East, Japan and Russia (the latter two not being in the whole sample), but with the addition of Papua New Guinea.

These regions are still fairly heterogeneous, but certain features peculiar to each region can be identified. The Middle East is of course the region most affected by interstate conflict, with the ongoing Israeli-Arab confrontation a ubiquitous factor, and high international interest due to the presence of oil. Africa is characterised by low GDP per capita and low military burdens, but high levels of conflict, especially civil conflict. The Western Hemisphere is strategically dominated by the US, consists mostly of low to middle-income countries, has experienced very little interstate conflict, but large numbers of ideologically-motivated civil wars, coups and revolutions. Asia is perhaps the least homogenous of these regions, stretching from Pakistan to Indonesia; noteworthy features include a high rate of demand for major hi-tech conventional weapons systems across the region, and the status of much of the region previously as a crucial Cold War battleground, though the position was more settled by the '80s. Thus overall there is some reason to suppose that this subdivision of the sample may identify relevant regional patterns of demand.

Fixed effects models were estimated for each region[41]. Where the log Security Web variable did not produce a positive and significant result, the model separating hostile from non-hostile neighbours, i.e. using log Others and log Potential Enemies was also estimated. Table 6 below displays the regression results for the four regions. In all models, the dependant variable is log of military burden. Table 7 presents summary statistics for

[41] As in the full sample, China was included in the Security Web of all her neighbours in the Asia region.

each model. A number of points stand out. Firstly, External war is only significant in Africa and the Middle East. This is actually not surprising, as there was no external war in Asia during the period, and only the two brief Peru-Ecuador flare-ups in Latin America. Again not surprisingly, the variable has its highest coefficient in the Middle East, which has seen the biggest wars using the largest amount of high-tech weaponry, especially the two Gulf Wars. Civil war is significant and positive everywhere except the Middle East, where it is significant and negative. This result is hard to interpret. However the highest coefficient on Civil War is in the Western Hemisphere, followed by Africa, which reasonably reflects those regions' high propensity to internal conflict, frequently exacerbated by superpower rivalry. Again, Great Power Enemy is significant and positive everywhere except Middle East, where it is significant and negative. This may be because one of the "Great Power Enemies" in the region was Turkey, an enemy of the Soviet Union; it ceased to be so after the end of the Cold War, but this was at a time when Turkey's security situation became more tense, due to the Gulf War.

Turning to scale effects, Population, which was strongly negative in the whole sample and in the cross-section, is only significant and negative in the Middle East. Income, which was insignificant across the whole sample, has a negative coefficient in the Middle East and Africa, a positive coefficient in the Western Hemisphere, and is insignificant in Asia. It is possible that in the (relatively) peaceful Western Hemisphere, military expenditure is treated as a 'luxury' good which therefore has an income elasticity greater than unity, while in the conflict-ridden Middle East it is seen as more of a 'necessity', with an income elasticity of less than unity.

The Trade variable is negative in Asia and Latin America, positive in the Middle East, and insignificant in Africa. A priori, there are contradictory arguments for the effects of trade: on the one hand, Rosh (1988) predicts a negative coefficient on the grounds that countries more integrated in the world economy are less likely to adopt aggressive external postures; on the other hand one could expect a positive coefficient on the grounds that high levels of exports help finance arms purchases. From this standpoint, it is not entirely surprising that in the Middle East the latter effect is stronger; all countries in the region face high levels of tension and are not likely to be put off high military spending because of increased international trade; thus the financing effect is likely to predominate.

Democracy is negative and significant everywhere except the Middle East, where it is insignificant. Again it is possible that this is due to lack of variation in the variable: few countries in the region have changed their democratic status over the period. (Turkey is a rare exception).

Looking at the Security Web variables, Africa in either specification has log PE positive, but the non-hostile variable (log Others or log SW) negative. In the Western Hemisphere, in the nested specification, log PE is positive, and log SW is negative; in the separate categories specification, log PE is positive, log Others is insignificant. In Asia, we actually find that the variable for the whole Security Web is positive, and PE is insignificant, in other words there seems to be no distinction between the effects of different categories within the Security Web[42] (The other specification was therefore not used.) In the Middle East, with either specification, log PE is positive, the non-hostile variable insignificant.

Thus there is quite a lot of variation in these results between the regions, though there are some common threads. The strongest results would seem to be the positive effect of Potential Enemies spending (in Asia this only detectable as part of the general Security Web), and the negative effect of democracy (though in the Middle East this cannot be picked up due to lack of variation.)

[42] One possible explanation for this is that China should be counted a Potential Enemy for more countries.

Table 6: Regression results for regional panels.

	Africa model 1		Africa model 2		Western Hem. 1		Western Hem. 2		Asia		Middle East	
Variable	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
External War	0.298	2.1	0.270	1.9	0.056	0.4	0.074	0.5	N/A		0.875	8.1
Civil War	0.125	9.0	0.123	8.8	0.208	6.9	0.212	7.0	0.084	2.9	-0.193	-5.6
GPE	0.859	1.9	0.911	2.0	0.755	4.9	0.785	5.1	0.57	3.3	-0.730	-4.2
Democracy	-0.016	-4.5	-0.017	-4.6	-0.011	-2.4	-0.012	-2.6	-0.0145	-3.0	0.006	0.4
log POP	-0.003	0.0	-0.007	-0.1	-0.163	-1.4	-0.072	-0.6	0.16	0.5	-0.456	-3.0
log Trade	0.026	0.6	0.029	0.6	-0.127	-1.7	-0.137	-1.9	-0.14	-5.8	0.175	2.8
log GNP	-0.133	-2.0	-0.127	-1.9	0.327	2.6	0.305	2.4	-0.10	-1.6	-0.522	-5.0
log SW milex	-0.043	-2.2			-0.103	-2.2			0.36	4.2	-0.029	-0.4
log PE milex	0.029	4.2	0.021	2.8	0.082	5.2	0.065	4.5	-0.005	-0.25	0.063	5.9
log Others milex			-0.036	-2.0			-0.068	-1.3				

Table 7: Model statistics for regional regressions.

Region/model	Mean of dep. variable	R-bar sq.	SE of residuals	No. of observations	No. of countries
Africa (with log SW)	-3.65	.84	.307	595	41
Africa (with log Others)	-3.65	.84	.307	595	41
Western Hemisphere (SW)	-3.99	.77	.316	376	24
Western Hemisphere (Others)	-3.99	.76	.318	375	24
Asia	-3.42	.87	.264	304	19
Middle East	-2.31	.79	.334	217	13

4.6 Conclusions

In this chapter, we have used a Fixed Effects model to ascertain the factors affecting the demand for military spending within countries, complementing the cross-country picture provided by the previous chapter. This panel data evidence shows that many of the same factors that explain cross-country differences also explain within-country variations.

War, both external and civil, is clearly shown as a major determinant of military expenditure. The Post Cold War period experienced much fewer interstate wars, which may be one reason for overall falls in military spending. While the cross-section results for that period seemed to show that indeed external war was no longer a significant influence on military spending, the variable was significant in the panel data model both for the whole combined period and for the Post Cold War period alone. The most plausible explanation of the insignificant result in the cross-section is simply that there were too few occurrences of external war to give a meaningful result. The within-groups Fixed Effects estimator shows clearly that the same country is likely to spend more when at war then when not.

The effect of military spending by Potential Enemies is also reproduced by the within-countries estimator, suggesting that countries in general do respond to changes in military spending by their rivals. Thus, although we have avoided estimating Richardsonian arms-race models, there is some evidence here of arms-race type effects around the world, though only as one of many factors affecting military spending. We have considered an alternative explanation for the Potential Enemies result: that it represents the effect of countries entering and leaving the Potential Enemies category, rather than changes in military spending by Potential Enemies; however the negative coefficient on the 'Hostility' coefficient of Potential Enemies/Security Web, suggests that changes in military spending levels by existing rivals are indeed an important factor.

On the other hand, evidence of countries' response to changes in military spending by non-hostile neighbours is highly ambiguous, depending on specification; when we use the nested specification using Potential Enemies as a sub-category of Security Web, the former has a positive coefficient and the latter negative; but when we separate out the non-hostile countries of the Security Web into the 'Others' category, we get a positive coefficient on both log PE military spending and log Others military spending. These contrasting results are hard to interpret and can give little evidence either way.

The cross-sectional result that population has a negative relationship with military burden is also confirmed by the Fixed Effects Model, while we again find no evidence (in the full sample) that overall level of income effects military burden one way or the other: a unitary income elasticity of demand appears to operate both across countries and over time. However there seem to be significant regional variations in these results; it is only in the Middle East that the population effect is significant, while in different regions, we seem to find income elasticities of demand either greater than or less than unity.

Democracy is again shown to have a negative relationship with military spending. The period in question involved many countries which made the transition to democracy, as well as a few that went the other way. This study therefore provides evidence that such regime changes have had an important effect on their military posture.

We posed three specific research questions posed in section 3.1.2, and we may now compare the answers provided in this chapter to those in the last. Firstly, do countries respond to high general levels of militarisation in the region by maintaining high military burdens themselves, even in the absence of a specific threat from their neighbours? That is, is there a "keeping up with the Jones'" effect? Here, we have found a highly ambiguous answer, with one specification bearing out this hypothesis, but another actually giving the opposite result. This mirrors the fact that in the cross-section results, it was impossible to distinguish the effect of non-hostile neighbours' military spending from that of their overall economic size.

Secondly, is the response to military spending by hostile neighbours distinguishable from this general response to high levels of militarisation in the region? Here, we have a fairly unequivocal positive answer, both here and in the cross-section data, with the strong significance of Potential Enemies military spending. This held true in the whole sample, in both periods, in three of the four regions, and when additional tests were performed such as including the Hostility ratio.

The final question was, has civil conflict become a more significant determinant of military spending relative to external threat since the end of the Cold War? The panel data model, in contrast to the cross-section results, offered strong evidence that there has been some sort of change in the patterns of demand. Whether or not we allowed the fixed effects dummies to change, the hypothesis that the slope coefficients were the same for both periods was clearly rejected. However it is not entirely clear what the nature of this change is, as the results for the Cold War period alone are of a poor quality. Both specifications showed Civil War having a significantly higher coefficient in the second period, supporting a positive answer to our question. When we allowed the fixed effects dummies to vary, we also found the coefficient on Potential Enemies military spending ceasing to be significant after the end of the Cold War, which also supports the hypothesis that external threat has become relatively less important. On the other hand, External War gained in significance in this model, which suggests the opposite. However this may simply be due to the enormous impact of one war in particular, the Gulf War of 1990-91, on the military expenditure of its major participants. Overall, these results would seem to give cautious support to this hypothesis.

Looking at the this chapter and the previous one together, we have established a strong picture of the determinants of military expenditure as the product of three essential categories of factors, or 'dimensions': economic, political and security, with the last one comprising both external and internal factors. In the next chapters, these three dimensions will be used as a starting point for exploring the demand for military spending in three specific case studies.

Chapter 5. The Demand for Military Expenditure in three South American countries

5.1 Introduction

The preceding two chapters have given us a broad picture of the determinants of military expenditure across developing countries, looking both at differences between countries and differences within countries over time. However such analysis only gives us broad generalisations and average relationships, and we have seen evidence from the previous chapter that these relationships vary quite substantially between different regions. The dominant factors that determine military spending – economic resources, rivals' military spending, war, regime type etc. – are likely to be conditional on the specific features of particular countries, and we must examine such features more closely if we are to understand the dynamics of military spending in individual cases.

The next two chapters will attempt to do this in the cases of Argentina, Brazil and Chile, looking at data between 1970 and 2000. There are a number of features that make these countries of interest, in that they have seen considerable changes in all three of the dimensions, economic, political and security, that we have identified as the important determinants of military spending. Firstly, in common with the rest of South America, of which they are the three largest economies, they have experienced a turbulent economic ride over the period in question, especially with the debt crisis from 1982 onwards, and hyperinflation in the late eighties and/or early nineties in the case of Brazil and Argentina. All these factors are potentially highly significant for military spending, placing severe constraints on a country's spending in general.

Secondly, all three have experienced a transition from military to civilian rule[43] in the period in question. Chapters 3 and 4, in common with other studies, found a negative impact on democracy on military spending, so we will have the opportunity to test this effect in these particular cases. However, the circumstances of transition differed considerably between the three countries, in particular in terms of the degree of power and influence retained by the military post-transition. Such considerations may well qualify the expectation of a drop in military spending following the regime change. We shall therefore analyse the patterns of civil-military relations in these countries and their likely effect on military spending in some detail.

Thirdly, although South America is a region of relatively low military spending, arms purchases and conflict compared to other parts of the world, developing or developed,[44] there are nonetheless important strategic issues facing these countries, especially the changing state of relations between Argentina and Chile. It is therefore interesting to examine whether these considerations remain important in determining military spending in a general context of low tension and threat of war.

In the following chapter, we will present time-series estimations of demand functions for military expenditure in these three countries. In this chapter, we shall analyse the processes affecting military spending levels in our case studies at a qualitative level, from the point of view of the economic, security and political dimensions. Section 5.2 will briefly reassess the theoretical utility-maximising basis for demand for military spending in the South American context. Section 5.3 presents the data series for military expenditure used in this study, and gives a brief overview of how military spending levels

[43] Argentina in fact experienced two transfers of power by the military, in 1973 and 1983, the first short-lived, the second seeming more permanent.

[44] The only two cases of interstate warfare between countries in the region were two brief flare-ups between Ecuador and Peru over a disputed border in 1981 and 1995. Argentina also fought a brief war against the UK over the Falkland Islands/Malvinas in 1982. Peru and Colombia have suffered major long-running civil wars in the 1980s and 1990s.

in Argentina, Brazil and Chile have varied over the past 30 years. Section 5.4 examines the economic problems facing these countries and their likely impact on military expenditure. Section 5.5 explores in detail the Security dimension, in terms of external defence and ambition, internal conflict and, briefly, "new" security threats and missions, such as drug interdiction and international peacekeeping. Section 5.6 analyses and contrasts the democratic transition processes and subsequent patterns of military-civil relations in the three countries, and the possible implications for military spending. Section 5.7 concludes. A brief chronology of major events in Argentina, Brazil and Chile is included in appendix 3 for reference.

5.2 Modelling military spending in South America

Neo-classical analysis of military spending, the basis of our empirical models in the previous chapters, regards such spending as a 'public good', purchasing 'security' for a nation, which must be weighed up against other, civilian goods and services that the nation can produce. Thus, the level of military spending will depend on the degree of threat, actual and potential, faced by the country, in the form of wars, disputes with neighbours, arms build-ups by such neighbours, and so forth – and by the available economic resources available for either military or civilian use.

This model, albeit with certain extensions, is a useful starting-point in analysing the demand for military spending in South America, but is not the whole story.

Some qualifications can easily be incorporated into this framework, and have already been discussed in chapter 2; for example the notion of the 'public good' purchased by military spending must be broadened, to include the 'prestige' factor of demonstrating a country's prowess and position in the world by its military might. Such motivation is particularly true of Brazil, which has long sought great power status.[45] Secondly, we must consider the role of the military in combating insurgency within the country, and in the case of autocratic governments, suppressing internal dissent. From this perspective, we must see the traditional model in terms of the government maximising its own utility function, rather than the welfare of the people as a whole, or of the 'median voter' as some models suggest.

Much bigger problems arise when we consider the role of the military as a powerful political player within the state. Even when they do not wield direct rule, in many South American countries they have maintained a tutelary role over civilian government, reserving the right to step in if political and economic developments are not to their liking. (e.g. Fitch, 2000) Again, even if this direct influence is fairly limited, the military have remained powerful autonomous actors, whose subordination to civilian government is always conditional. The Western model, of unconditional submission to the democratically expressed will of the people, is essentially non-existent in South America (though Argentina is approaching that condition.) (Fitch, 2000)

In this context, military spending must be seen as satisfying the needs and wants of a powerful political actor. For a military government, it is rewarding and ensuring the loyalty of their own; for a civilian government, military expenditure may take the form of, to put it bluntly, protection money for an unpredictable and dangerous armed body. More properly, we may wish to describe military expenditure as being at least in part a form of economic rent, in the sense that the military may have to be paid to ensure that it does not use its monopoly of the use of violence, over and above that which would be required for national security. It follows that the state of civil-military relations, analysed in section 6,

[45] And indeed a permanent seat on the UN Security Council, see e.g. Latin American Weekly Report (LAWR), 2/11/95. Argentina has also sought to rival Brazil, at least in terms of regional hegemony, see e.g. International Defence Review (IDR) June 1981.

is crucial to understanding the demand for military spending. Such considerations may lead us towards an 'institutionalist' explanation of military expenditure, rather than a neo-classical one. It is of course possible that a combination of these factors are at work; a civilian government might genuinely wish to fund the military to achieve national objectives, while also considering the effect of budgetary choices on the military's degree of co-operation with the government. Thus while economic and security considerations will likely remain important, we must pay close attention to the political dimension, and seek ways of including variables that reflect the military's influence and rent-exacting capabilities.

5.3. Military expenditure data for Argentina, Brazil, Chile and Peru

This section describes how usable data series for military expenditure in Argentina, Brazil, Chile and also Peru (included as a possible determinant of military spending for Chile especially) were constructed. The section will also give a brief overview of the levels of military expenditure in absolute terms and as a share of GDP over the period 1970-2000.

The problems afflicting military expenditure data referred to in chapter 3 are particularly severe in many Latin American countries, including the ones under study. There is a strong tendency for governments to understate data, by means such as hiding military expenditure items in other budgets such as health and social security. Military pensions, for example, are often moved to the Social Security budget, and military healthcare to the Health budget and so forth. The militaries in these countries also have had access to extra-budgetary sources of income: revenue from military-run industries, including but not restricted to the arms industries; royalties from other state-run industries (in particular the Chilean military's 10% share of the revenue of Coldeco, the state copper company); proceeds from sale of surplus equipment, an so forth. (SIPRI 1986). In 1985, the World

Bank examined Argentine central government accounts for the period 1961-82 and found that military-related expenditures during the period 1970-82 were about 50 per cent higher than indicated by the official data. (SIPRI, 1986). Obtaining accurate figures requires very careful analysis of government expenditure data, where this is available. Another factor that severely complicates the issue is the hyperinflation that beset many of these countries in the eighties. In a year of hyperinflation, money spent at the start of the year is worth much more than money spent at the end, but this may not be accounted for. This problem seems particularly severe in the case of Brazil, where the available figures become extremely erratic in the late eighties/early nineties. Figures published by organisations such as SIPRI and ACDA are frequently revised, so it is not possible to chain together figures from different yearbooks produced by these organisations to obtain a longer series.

To obtain series that are as consistent, inclusive and reliable as possible, the author examined a variety of sources in the military expenditure archives of the Stockholm International Peace Research Institute (SIPRI), so as to ensure that the data used was, as far as possible, consistent back to 1970, rather than just the period covered by a single SIPRI yearbook. I therefore also sought to use data that conformed as closely as possible to the SIPRI definition of military expenditure, which is similar to the NATO definition. This is fairly inclusive, aiming to cover all items that contribute to the cost of the military establishment – this includes contributions to military pensions, military healthcare, etc. It excludes civil defence, and the cost of past military activities, such as weapons destruction and demobilization. More details may be found in most editions of the SIPRI yearbook, for example SIPRI (2002). The following four sections describe the construction of the data series.

5.3.1 Argentina

This study uses military expenditure data from 1970-1999 prepared by Thomas Scheetz, based on a close breakdown of Government expenditure data from Argentina's *Memoria de la Hacienda.* This analysis has sought to include items of expenditure such as military pensions that are excluded from the official defence budget. A slight adjustment has been made to the data from 1970 to 1975. This is due to a change in the methods of recording data used by the *Memoria*, from accounting by jurisdiction, to accounting by function. It is likely that expenditure with a military function, but under a different jurisdiction, is omitted from this dataset up to 1975.

A comparison with other reasonably reliable data series gives an idea of the magnitude of this. Up to 1975, the Scheetz data coincides exactly with a series prepared by Nicole Ball at SIPRI (Ball, 1984), which ran up to 1980. Thereafter, Scheetz' figures are higher. This picture also applies when comparing this dataset with that in the IMF's Government Financial Statistics Yearbook (GFSY). Scheetz's data is consistently higher, but the ratio between the two jumps from 1976.

The Scheetz series up to 1975 was therefore up-rated by a factor of 1.6, which is the ratio of Scheetz's data to Ball's in 1976. This ratio varies up to 1980, between 1.6 and 1.84, but the 1976 ratio was chosen in preference to the average, both because it is the closest in time to the up-rated observations, but also because it ensures that the growth rate from 1975 to 1976 in the resulting series is the same as in Ball's.

5.3.2 Brazil

This proved most difficult, as there was no single series, even an unreliable one, running through the entire period of interest. For the early period, up to 1979, The data from Ball (1984) can be regarded as reliable, based as it was on a careful analysis of official expenditure data. From 1992, the Brazilian embassy have been submitting detailed replies to SIPRI's military expenditure questionnaires, which include items not believed to be included in other series, so these also carry a reasonable degree of credibility.

Between these dates, there are two alternatives: data from official government statistical yearbooks, and the figures submitted to GFSY. Both are rather lower than the other series in the years in which they overlap, and both are very erratic for the hyperinflation years. The GFSY figures were chosen for a number of reasons: first there were gaps in yearbook data available from SIPRI's archives; second, the yearbooks changed their method of calculation in the mid-eighties in a way which substantially lowered the figures; and third, the official data seemed even more erratic and unbelievable in the hyperinflation years than did the GFSY.

The remaining question was whether to apply an up-rating factor to some of the series to account for some being consistently higher or lower than others. The problem here is that the ratios between the series on overlapping years are not at all consistent, and are further thrown out by the hyperinflation problems. The fact that the GFSY data is generally lower (by a factor of 1.11 to 1.54) than the questionnaire responses on their five years of overlap does not mean that all the other GFSY observations are likewise too low. To assume such could risk muddying the relationship with other long-term variables such as GDP. (GFSY and Ball's series are fairly close to each other, and in fact crossover, though Ball's figures are usually higher. At the 'join' year of 1979 they are almost identical.) Therefore the series were used as they stood.

Although the series used seem to be the most reliable and inclusive that could be found, it should be noted that items such as military pensions are excluded.

5.3.3 Chile

Up to 1991, data prepared by Tom Scheetz was also used, again composed from a careful analysis of government expenditure data, and including a lot of items not included in official figures. (In particular, arms purchases are buried in a lot of places, not just the 10% share of copper export sales that the military is guaranteed for arms purchases).

For later years, a number of different sources exist. GFSY data is almost certainly too low, including only official budgetary data, and not for example the copper fund. Chilean embassy responses to SIPRI questionnaires are higher, but are inconsistent with each other. Rather more promising are IMF staff surveys, where military spending data is available from 1994 onwards. These include both military pensions, and the proceeds from copper sales, and give higher figures than other series that run contemporaneously. In general, it is far more common for governments to hide military expenditure which data collectors must then dig out, than for data collectors to mistakenly attribute expenditure lines to military expenditure, and so these higher figures from the IMF may be considered more believable.

This leaves a gap for 1992-1993, as well as a problem that the IMF series and the Scheetz series do not overlap, making it difficult to compare them.

Of the possible series to fill the gap, the earlier of two sets of SIPRI questionnaire responses was chosen; the reason for this is that this series maintains a more stable ratio with other series than the other possibilities. Furthermore it overlaps both the IMF and the Scheetz series for a number of years, giving some point of reference between the two.

The two questionnaire responses for 1992 and 1993 were up-rated by a factor of 1.98, being the ratio of the Scheetz data to the questionnaire in the year before the join of 1991 (and very close to the ratios for 1989 and 1990). The IMF figures were uprated by a factor of 1.075, being the necessary factor to raise the 1994 IMF figure to the questionnaire figure times 1.98 (thus matching the uprating to the Scheetz series.) Again, this figure is relatively stable.

5.3.4 Peru

Peru is not one of the countries under study; however as a major player in the region, and specifically as a long-standing rival of Chile, its military spending is potentially a significant determinant of those of its neighbours.

Up to 1992 data from Thomas Scheetz was again used. After this, all data derived from official sources dries up. The Peruvian government, engaged in major offensives against the Sendero Luminoso guerrillas, and ruled by an increasingly authoritarian President Alberto Fujimori, refused to publish any data. Therefore the only available sources are those relying on intelligence reports: the US ACDA, and Britain's International Institute for Strategic Studies (IISS). Such data is unsatisfactory in many ways, in that it is not transparent, so that the quality of the 'intelligence' sources used is unknown. However it is all that is available.

The IISS data for defence budgets was chosen in preference to ACDA data, or IISS expenditure data, as these figures maintained the most stable ratio with the Scheetz data in the years of overlap. The IISS data was up-rated by a factor of 1.09, the ratio of Scheetz to IISS in 1992. As the sources of IISS data are not transparent, it is not possible to be certain what is or is not included in IISS data.

5.3.5 The trajectory of military spending in Argentina, Brazil and Chile.

Figures 1 to 7 below plot the military spending levels (in constant local currency) and the military burdens for Argentina, Brazil, Chile and Peru, using the series described above. Data tables for the series are included in appendix 4.

In Argentina, military spending tended to rise through the 1970s and early 80's and subsequently declined. The sharp rises in military spending started in 1975, one year before the *proceso* dictatorship took over. It peaked between 1979 and 1983, then fell sharply till 1990 and levelled off thereafter.

In the graphs for Brazil, the problem of hyperinflation distorting figures is clearly illustrated, with apparent wild fluctuations in military spending in the late eighties/early nineties. As noted above, there is also an issue of the join between the different data series used for different periods, though this is not immediately apparent from the graph.

Thus, any statements about Brazilian military spending must be somewhat qualified and tenuous. Nonetheless the pattern that seems to emerge is of military expenditure falling both in real terms and as a percentage of GDP over the seventies and early eighties, with the GDP share rising thereafter, and the level rising more rapidly as most of this period was one of economic growth. The exception to this was the hyperinflationary blip of the late 80's, where as discussed, this data is somewhat dubious.

In other words, military expenditure as a share of GDP seems to have fallen during the period of military rule, and risen slightly thereafter – the opposite of what one might expect from the results of the previous chapters.

In Chile, military burden rose dramatically but erratically through the 70's and early 80's, though there are noticeable peaks in 1974 and 1978, times of high tension with Peru and Argentina respectively. Thereafter the military burden declined steadily, though it levelled out in the late 90's. The fall clearly predates the restoration of democracy in 1989. In terms of the level of military spending, this represents a rapid rise through the early period, and a more gradual rise thereafter.

Peruvian military spending follows a remarkably similar pattern to Argentine military spending, though it peaked slightly earlier. This is slightly curious, as Argentina and Peru do not share a border, and are in some ways allies, with Chile as a common potential enemy.

Figure 1

Figure 2

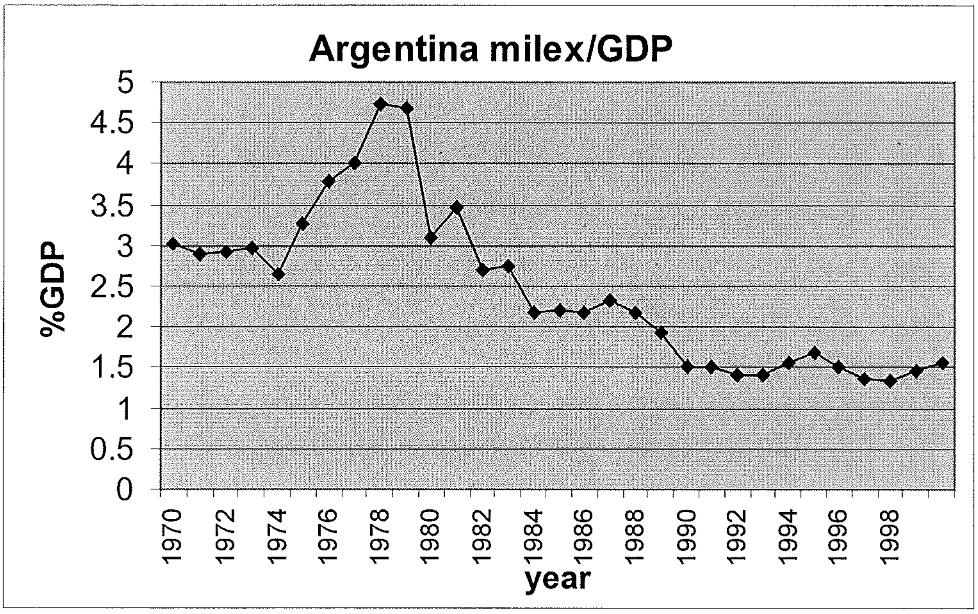


Figure 3

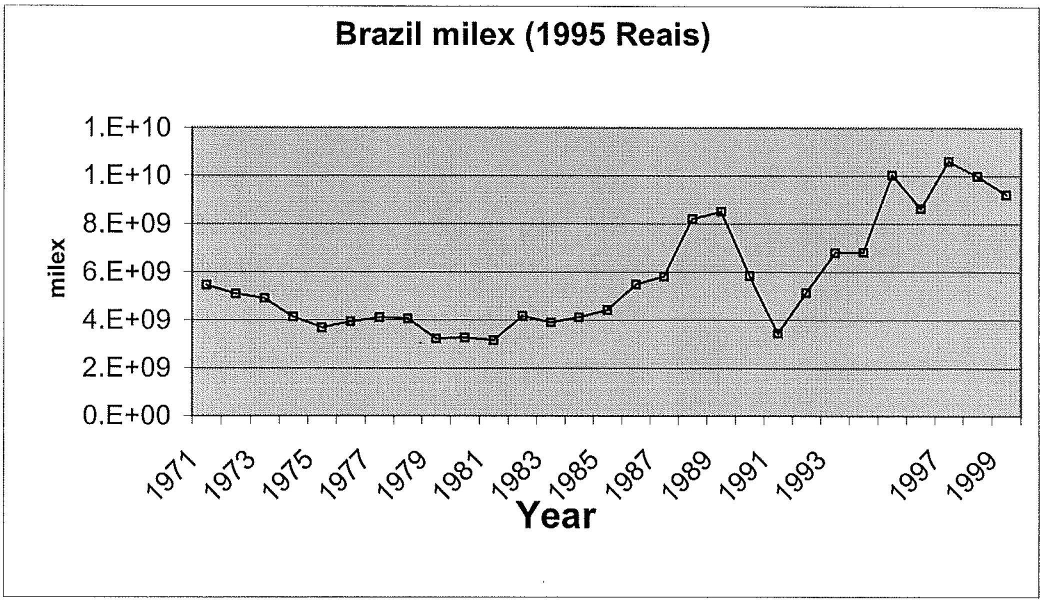


Figure 4

Figure 5

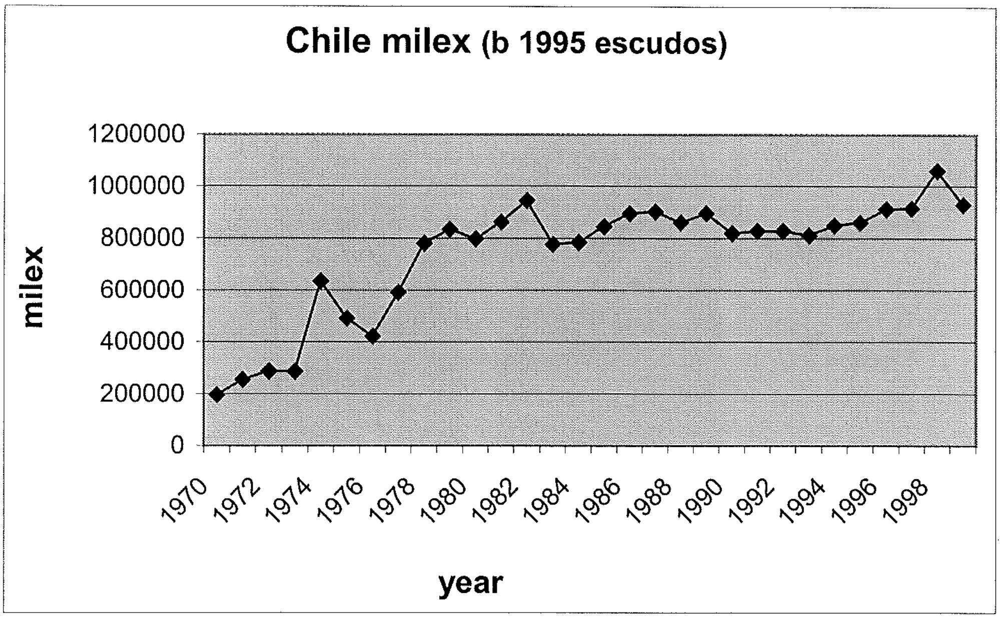


Figure 6

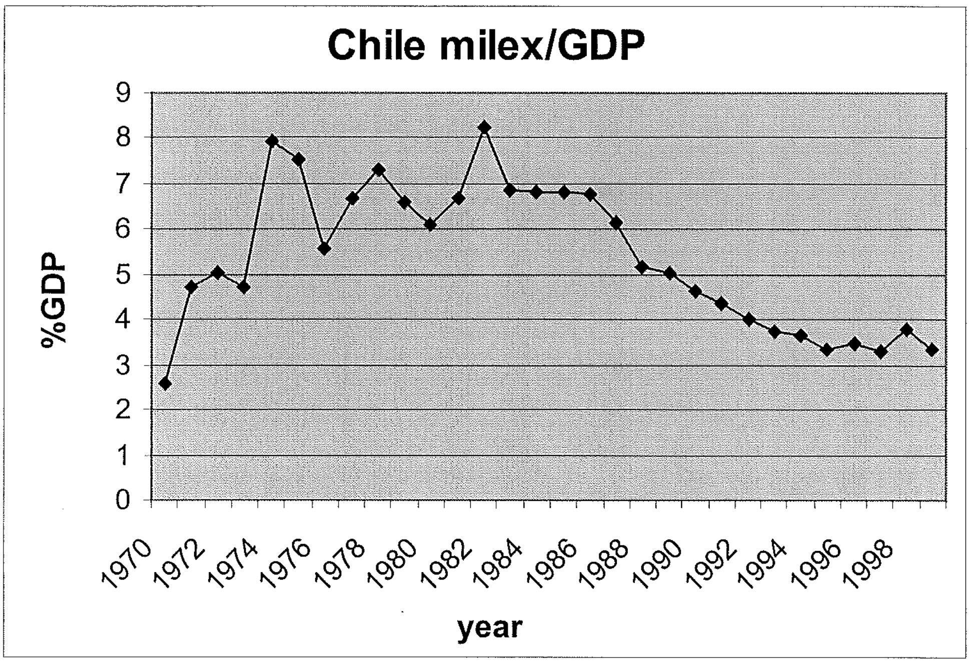
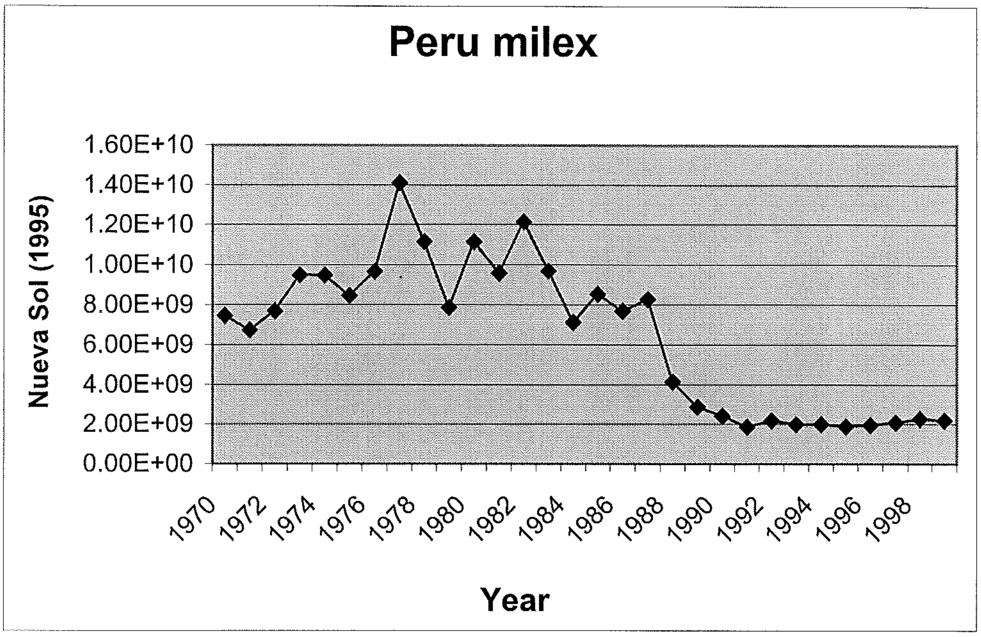


Figure 7



Peru milex
Nueva Sol (1995)
1.60E+10
1.40E+10
1.20E+10
1.00E+10
8.00E+09
6.00E+09
4.00E+09
2.00E+09
0.00E+00
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
Year

5.4. The economic dimension

Most Latin American countries have had a bumpy economic ride over the past thirty years, in common with much of the developing world. Argentina, Brazil and Chile have all faced periodic severe recessions, heavy debt burdens, and bouts of hyperinflation, and these economic factors are likely to be important in analysing the demand for military spending. Whatever the political and security factors motivating military expenditure, the availability of resources must impose constraints on spending. The neo-classical model we have loosely been using starts from a budget constraint. Both the cross-section study in chapter 3 and the panel data study in chapter 4 found military expenditure to be roughly proportional to national income. We therefore start by analysing the economic progress of Argentina, Brazil and Chile over the past thirty years, in relation to growth in national income, the debt crisis, and problems of inflation.

Figure 8 shows the GDP growth rates of Argentina, Brazil and Chile from 1970-2000. In this area Argentina has probably had the patchiest record. The early seventies showed steady, modest growth, but the economy stagnated in the early years of the *proceso* junta. There was some recovery in 1979-80, but severe recession followed in 1981-82, partly prompting the disastrous Falklands military adventure. The Alfonsin government, though enjoying high levels of goodwill in its efforts to tackle the power of the military and embed democratic rule, did not fare well economically, leaving a lower level of GDP in 1989 than when it came to office in 1984. The second democratic President, Carlos Menem, however, presided over what has frequently been described as an 'economic miracle', with high and fairly consistent levels of growth.[46]

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[46] Of course, the recent collapse of the Argentine economy following years of recession has shown the Menem administrations economic performance in a rather different light. However it is not the place of this

Brazil achieved impressive growth rates in the seventies, followed by a recession in the early eighties. After this there was mostly fairly modest growth (3-6%), punctuated with occasional downturns, the most severe in 1990. In the past couple of years, the economy has stagnated somewhat.

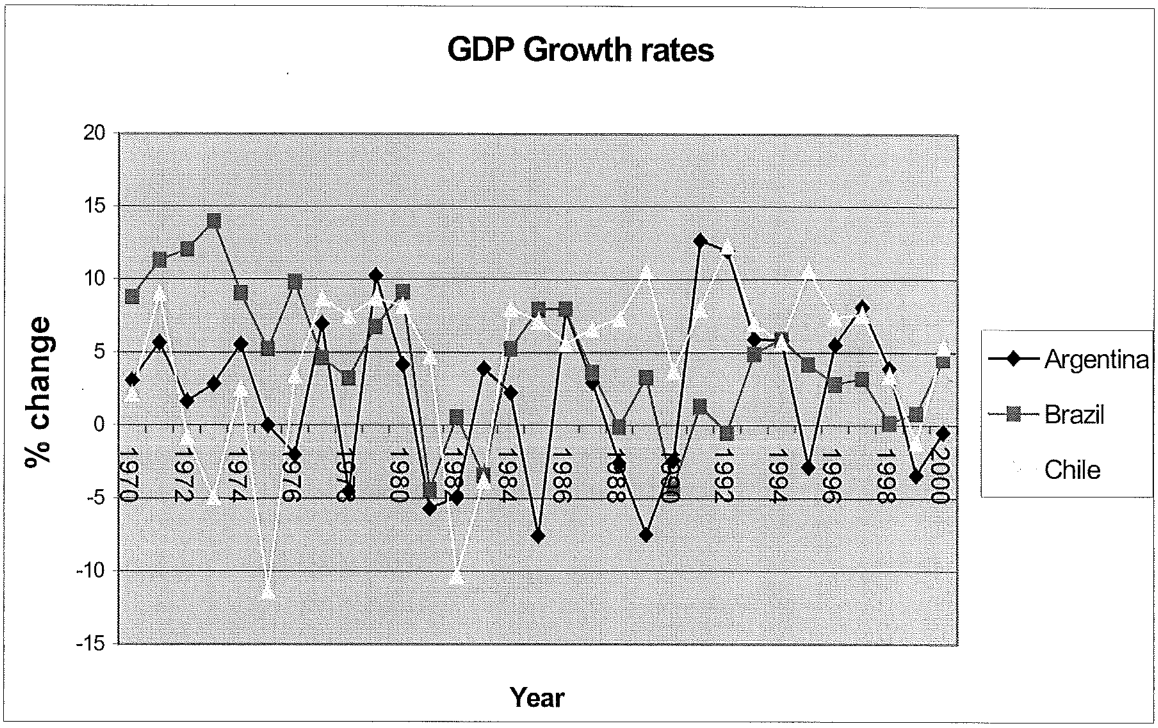
The first year of the Allende government in Chile (1971) saw 9% growth, but this was followed by recession. After another severe recession in 1975 (-11% growth), the Pinochet regime, with its hardline monetarist policies[47], achieved solid growth for the next six years. Another severe recession in 1982-83, however, helped produce a re-invigorated opposition staging regular national protests against the dictatorship.[48] Since then, growth has again been solid and sometimes very strong indeed, both under Pinochet and under the subsequent democratic administrations. (In fact democratic rule since 1990 has averaged almost twice the average growth rate achieved under Pinochet.)

thesis to evaluate the economic policies of successive Argentine administrations, but simply to present the economic backdrop to military expenditure decisions.

[47] E.g. Souther (1998)

[48] E.g. http://www.derechoschile.com/english/protest.htm

Figure 8



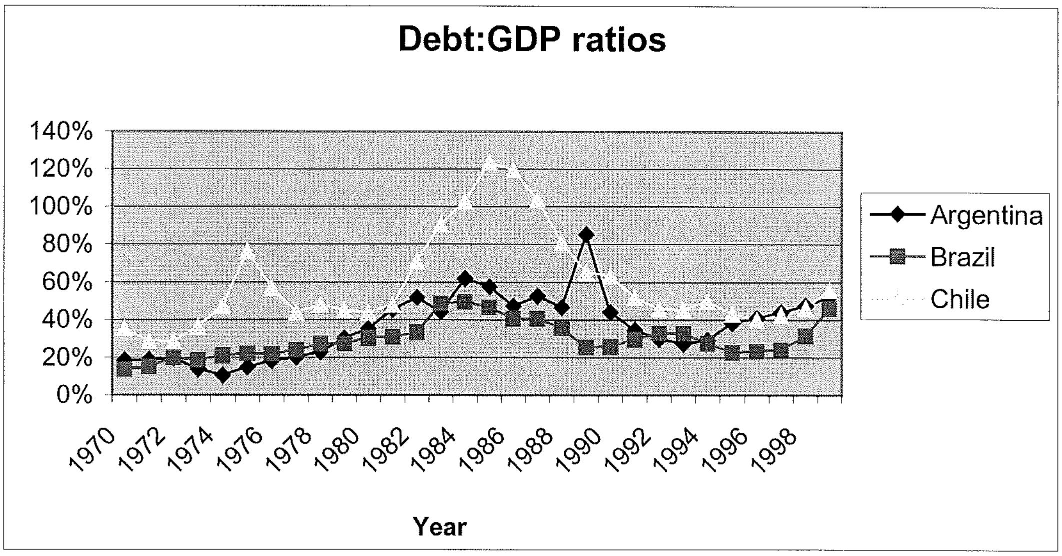
As well as the overall level of national income, debt, and with it debt service requirements, are an important restraining factor on public expenditure. This is likely to apply especially to items such as arms imports dependent on foreign currency availability, (hit by debt service payments) and on external financing which may be impeded by a high debt burden. Robert Looney (1986) in a cross-sectional study of Latin American military spending, found that debt and/or debt service had a significant negative effect on overall public-sector consumption, which he in turn found to be a primary determinant of military spending.

The debt crisis hit Latin America hard, caused by heavy lending by banks and international institutions in the 1970's, followed by rising interest rates, leading to unsustainable debt service requirements. The crisis broke in 1982, when Mexico announced she would be unable to continue servicing her debt. Rescheduling packages were generally agreed with the creditors, but debt service payments remained very high as a proportion of exports, restricting access to foreign currency (e.g. IIS 1988). Argentina, Brazil and Chile were severely affected along with the rest of the region.

Figure 9 shows the debt to GDP[49] ratios of the three countries from 1970-2000. Argentina's debt burden rose rapidly through most of the late seventies and the eighties, reaching a sharp peak in 1989 before falling sharply, then rising again from the mid 1990s. The Brazilian debt/GDP rose more steadily throughout the seventies to a peak in 1984, before falling back somewhat, then also rising from the mid-1990s. The Chilean debt burden hit a peak in 1975, possibly due to the very sharp drop in GDP that year, before falling back. It accelerated wildly after 1982, reaching over 120% in 1985, before falling equally sharply, returning to levels comparable with the others by the mid-90's, then joining the rising trend.

[49] The figures used are for Public and Publicly Guaranteed Debt, from the World Bank World Developmnt Indicators, defined as "long term external obligations of public debtors, including the national government and political subdivisions (or an agency of either) and autonomous public bodies, and external obligations of private debtors that are guaranteed for repayment by a public entity", see World Bank website, http://www.worldbank.org/data/wdi2002/pdfs/table%204-16.pdf.

Figure 9



These fluctuations in growth and debt levels must a priori be expected to have a significant impact on military spending for the reasons discussed. However, where the military is politically powerful, military spending may not be all that responsive in the short to medium term to changes in economic circumstances, as military influence may shield their budget from the pressures upon other departments. In addition, ways can be found round budget cuts:

"Civilian governments have understood ... that austerity measures taken to meet the problems of debt repayments and other economic ills are not to apply to the funding of the armed forces. Military expenditure reductions can therefore be cosmetic rather than real." (SIPRI Yearbook 1986, p. 227)

The same article then describes how the effects of budgetary clampdowns on the Argentine military was mitigated by means such as loans to bypass wage-freezes, the transfer of pensions to the social services budget, and the amortisation of arms loans to the treasury. Furthermore, according to the same article,

"Second, during their years in power, the military have been able to draw on sources of wealth beyond those allocated in military budgets. There is evidence that this habit has not changed. During the military regime in Argentina, loans taken in the name of the state oil company … were used to finance arms purchases. Under … Alfonsin, the naval budget has been cut; the navy however is seeking to supplement its allocation by selling off a package of naval equipment said to be worth $700m. In Brazil, the civilian government has given the Army permission for the first time to raise a foreign loan for the purchase of equipment. In Ecuador, the armed forces receive a royalty – said to be 15% - on all oil revenues, and in Chile the armed forces receive a royalty on the sale of copper."

The revenue for the Chilean military from the sales of copper is of particular significance as this gives the military a guaranteed source of income. The 1980 constitution guarantees the Chilean military a 10% share of the sales of the state copper company, Coldeco, for arms procurement, with a minimum of $180m. (In fact it averaged around $300m)[50]. In addition, the 1989 budget level was set as a floor for the main military budget. Furthermore, the armed forces are able to borrow ahead against copper revenues, further insulating them from budgetary pressures. (Scheetz, 1996)

In some cases, supplier countries eager to promote arms exports may offer generous credit terms to overcome current economic obstacles to purchases: Flight International of 21-27/7/93 reports that the UK's rescheduling of Brazil's debt in January 1993 was thought to have been to allow Westland to sell eight new Super Lynx helicopters to Brazil, and upgrade 6 existing aircraft.

[50] LAWR 15/12/98

For all these reasons, it is possible that the economic linkages to military expenditure, in terms of resource constraints imposed by levels of growth and international debt, may not be as strong as might initially be expected.

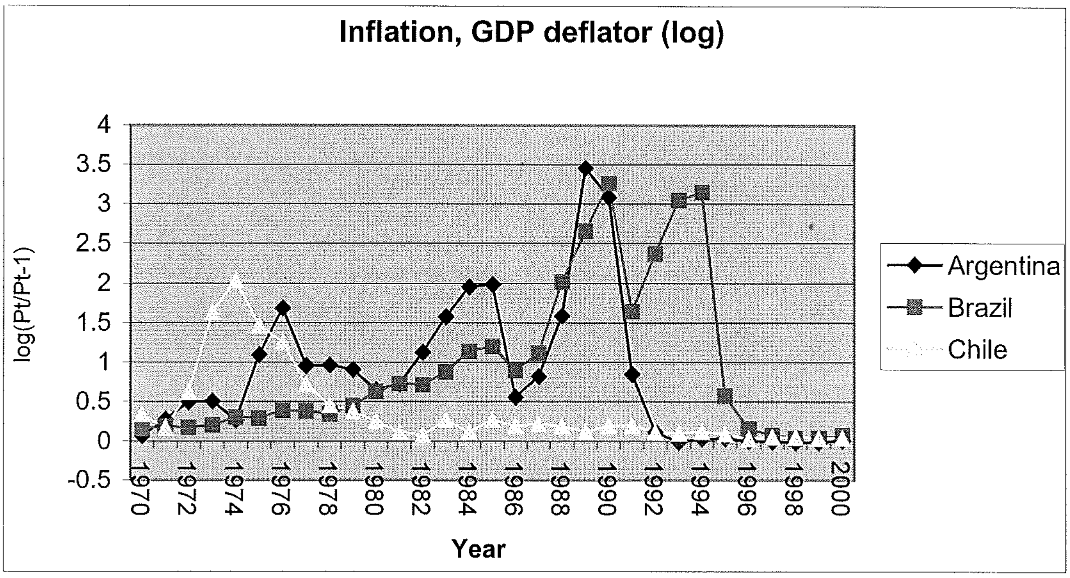
Income and debt represent basic resource constraints on public and specifically military expenditure. The problem of inflation is somewhat different, representing more of a stability and adjustment issue. Though there has been little or no empirical testing of a linkage between inflation and military spending as such, inflation is potentially an important determinant of military spending, at least in the short term. Although the overall level of prices should play no part in a normal demand function, there are at least two ways in which military expenditure (as well as other categories of public expenditure) could be affected. Firstly, cuts in public expenditure are a common policy response to high inflation. Secondly, in times of rapidly accelerating inflation, public sector salaries, including military salaries, may lag behind inflation due to political delay in bringing forward pay increases. Various news reports from the eighties do indeed show military figures complaining of the impact of inflation on military salaries.[51] This second consideration essentially relates to unexpected inflation, which has not been accounted for in annual budgeting and pay rounds. This is generally rather difficult to estimate, but one simple way of proxying it is by the rate of change of inflation; this is particularly likely to pick up the effect whereby sudden hyperinflation leaves salaries behind.

Figure 10 graphs the inflation rates for Argentina, Brazil and Chile from 1970-2000. The figure plotted is the log of the ratio of the current to the previous year's GDP deflator, as graphing the percentage rate would cause problems of scale. Argentina suffered from persistent high inflation, with the rate only below 100% in two years between 1971 and

[51] E.g. JDW 9/5/92

1999, and with severe hyperinflation in 1989-90. After this, the Menem administration brought inflation down to stable single-figure levels. In Brazil, inflation was over 100% from 1981 to 1994, with severe and persistent hyperinflation from 1988-1993. After this, as in Argentina, the rate was brought under control. Chilean inflation was in three figures between 1973-77, reaching a height of 665% in 1974, but was subsequently brought under control. General Pinochet's economic policies were strongly influenced by US-educated advisors schooled in monetarist theory. (E.g. Souther (1998)). It is therefore possible that this would have led to general public expenditure cuts as a means of bringing down inflation, though one might expect the military to be spared austerity measures. Argentina and Brazil did not pursue such measures to tackle the hyper-inflation of the eighties, looking instead to price and wage-freezes through the Austral and Cruzado plans respectively, with mixed success. (e.g. IIS, 1988)

Figure 10



In summary, we may reasonably expect military expenditure, like all forms of expenditure, to be affected by economic resource constraints; however the precise nature of the relationship may depend as much on political as economic factors: the political power of the military to protect their budgets from austerity measures brought about by debt or poor economic performance, the autonomy of the military to find funding from extra-budgetary sources, and administrative lag in responding to accelerating inflation. Data tables for GDP, debt and inflation are included in appendix 4.

5.5 The Security dimension: internal and eternal threat and ambition

In a Neo-classical framework, security issues are the primary positive motive for military spending, representing the 'public good' purchased therewith by a government maximising a utility function, be that its own utility or the welfare of the country as a whole.

In chapters 3 and 4, we proxied external threats by the aggregate level of military expenditure of neighbours and rivals, and by a dummy for external war. Here we will attempt to take a closer look at the specific security contexts of our case studies, with a view to developing more specific empirical proxies. This section is divided into a number of subsections. The first will present an overview of the tangible external security threats facing these countries, and their less tangible power-projection motives for military expenditure. The second subsection will analyse more closely the interaction between the countries in the region, and the mutual impact of their military expenditure and arms acquisition decisions. This section will in particular discuss a critique of Richardsonian 'action-reaction' models for understanding these interactions given by Varas (1985). Thirdly, the previous chapters found internal threats to be significant as well as external. Section 5.5.3 will therefore look at the degree of internal conflict in the three countries. The final subsection will look at less traditional security issues such as international peacekeeping and drug interdiction that some countries in the region have looked to as new missions for the military in the context of greatly lessened regional tension in recent years, and which therefore represent potential new motives for military spending.

5.5.1 Conflict, tension and ambition

Armed conflict and the threat thereof has traditionally been the primary justification for military spending, and we start by looking at international disputes involving Argentina, Brazil and Chile with the potential for armed conflict. As tensions from these disputes waxed and waned, so we might expect higher or lower levels of military spending. Beyond this however, military spending may be motivated simply by the desire to assert sovereignty over a country's land and sea areas, aside for specific threat – and by ambitions to project power within the region and beyond. We shall look at this motive in particular in the case of Brazil.

Armed conflict between South American nations has been extremely rare this century. Since WW2, the only examples are brief flare-ups of a border dispute between Peru and Ecuador in 1981 and 1995. In addition there has been Argentina's war with an external power, the UK, in 1982 over the Falklands/Malvinas islands.

Nonetheless, there are or have been numerous border disputes and rivalries between the countries of the region that have had the potential to lead to war, and which have therefore provided reasons for arms build-ups. Many of the problems arise from ill-demarcated frontiers following the period of nation-building in the 19th Century, especially in barely-populated and undeveloped regions such as the Amazon and the extreme south of the continent.

The Peru-Ecuador conflict is an example of this, spawning the regions only armed conflict between states within the region since WW2. The dispute relates to the 'Amazon Triangle', an area of some 200,000 square kilometres gained by Peru in a 1941 clash.[52] Ecuador and Peru fought two brief and indecisive conflicts over the region in 1981 and 1995.[53] In 1998, the two countries signed a treaty defining the border and establishing commissions to deal with future disputed issues.[54]

Argentina and Chile have had numerous disputed borders, but the most serious of these concerned three islands in the Beagle Channel, in the extreme south of the continent, claimed by both countries. The discussion here is taken primarily from Martinus (1988).

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[52] http://www.onwar.com/aced/nation/eat/ecuador/fecuadorperu1981.htm
[53] As above, plus http://www.onwar.com/aced/nation/eat/ecuador/fecuadorperu1995.htm
[54] http://www.onwar.com/aced/nation/eat/ecuador/fecuadorperu1995.htm

The dispute arose from contradictory interpretations of a 19th Century treaty, which attempted to settle the border in the extreme south.[55]

In 1971 the dispute was sent to arbitration with the International Court of Justice. This ruled almost entirely in favour of Chile in 1977, but in January 1978 Argentina rejected the ruling, and both sides made increasingly bellicose noises, while carrying out troop and arms build-ups in the area, and exercising acts of sovereignty. War seemed imminent, and was only averted when both sides agreed to accept Papal mediation in January 1979. However tensions remained high, with a number of military incidents.[56]

The collapse of the military regime in Argentina following the Falklands defeat, and the subsequent rejection of armed force by the new democratic Alfonsin government, opened the way to a solution. A Joint Declaration of Peace and Friendship in January 1984, followed by a Treaty in November 1984, enshrined both sides' acceptance of a revised Vatican formula.[57]

Tensions between the two eased significantly following the Treaty, though this was not the only border dispute between the two. War over the other disputes was much less plausible however, especially given the new democratic regimes first in Argentina, then in Chile. All but one of these were essentially settled at a Presidential level in 1991,[58] though the

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[55] This treaty acknowledged as a *fait accompli* Argentina's occupation of much of Patagonia, previously protested by Chile, while giving Chile control of most of Tierra del Fuego island to the South, the Beagle Channel, and the strategically important Strait of Magellan. Argentina disputed the course of the Beagle Channel, and further insisted that the treaty enshrined the 'two oceans' principle, making Chile a Pacific power, and Argentina an Atlantic power. The maritime rights associated with the disputed Picton, Lennox and Nueva islands would have damaged this principle, and given Chile a foothold in the Pacific, possibly also affecting Argentina's Antarctic claims. Chile for its part never accepted the two Oceans principle. Thus the real issue here may be seen to be not so much the ownership of three tiny and uninhabited islands, but strategic maritime power. Argentina's desire to exercise control over the South Atlantic is key here.

[56] The Falklands War exacerbated this, with Argentine suspicions (later proved to be justified) of Chilean collusion with Britain

[57] This awarded the disputed islands to Chile, but restricted the associated maritime rights, allowing Argentina to claim that the Two Oceans principle was maintained.

[58] LAWR 8/2/91

deals were not all ratified by both legislatures until June 1999, finally putting an end to over a century of uncertainty.[59]

The threat of war between Argentina and Chile clearly has implications for their military spending. On the one hand we must consider the possibility of an 'arms race' between them, that is a positive mutual influence of the two countries' military spending. On the other hand, the waxing and waning of tension, from imminent war in 1978 to final peace in 1999 may in itself be a factor, and we shall attempt to proxy this process in our empirical model.

Chile also has had significant tensions with both Peru and Bolivia, following the 3-way War of the Pacific from 1879-1883, in which Chile captured significant chunks of territory from both the others. Bolivia in particular lost an outlet for the sea, and regaining such an outlet has been a perpetual priority of Bolivian policy ever since.[60] Since 1978, Bolivia has had no diplomatic relations with Chile.[61] Following Pinochet's military coup in Chile in 1973, many of their neighbours thought that this upsurge of militarism, combined with the ideological clash between Pinochet's right-wing monetarism and Peru's radical reformism and flirtation with Moscow, would lead to war between the two. (e.g. Guardian 11/11/1974). Bolivia in particular, hopeful of an improvement of their position, prepared for war, though none came. However Peruvian concerns were heightened when Chile launched a 'peace' move in 1976 to attempt to resolve Bolivia's landlocked status. (Varas, 1985). Although increased regional trade and democratisation have lessened tensions, the underlying dispute remains unsettled.

[59] LAWR 8/6/99

[60] E.g. Varas (1985), p55 "Bolivia has been entirely flexible in its alliances, willing to participate in any relationship that may lead to possession of an outlet to the sea"

[61] E.g. LAWR 8/8/96

Peru is a significant power in the region and has been a potential enemy of Chile. Therefore Peru's military spending shall be considered as a potential determinant of Chile's in the empirical work next chapter. Bolivia's military spending is perhaps too small to be considered as a significant influence and is therefore not included, as too many variables would lead to loss of degrees of freedom. In terms of the patterns of tension between the countries, there is not such a clearly identifiable sequence of events as is the case for Argentina and Chile; however a dummy will be included for 1974, the first year of Pinochet's rule in Chile and a time of considerable uncertainty in regional relations, as noted above.

While none of these disputes involving Argentina and Chile and others within the region ultimately led to war, Argentina did go to war with the UK in 1982 over the disputed Falkland Islands/Isles Malvinas.[62] In March 1982, as the Galtieri dictatorship faced economic crisis and growing unpopularity, and as Britain made moves indicating a lessened interest in the islands, Argentina invaded. Britain sent a task force to reclaim the islands, and as diplomatic efforts faltered, the issue was settled by armed force. The conflict claimed around 650 Argentine lives and around 250 British, and ended in June with Argentine surrender. This humiliating defeat led to the collapse of the military regime, and its replacement with what has proved a lasting democracy. (e.g. Hunter, 1996).

The war itself and its aftermath proved powerful drivers of military spending. First of all, around $800m of equipment was lost by Argentina during the war, which was more than replaced over the next two years.

[62] The Falkland Islands were seized by Britain from Argentina in the 19th century, and Argentina never accepted British sovereignty

Secondly, the war emphasised weaknesses in Argentina's defences, in areas such as reconnaissance aircraft, and most particularly nuclear submarines. The sinking of the Argentine cruiser the General Belgrano by the British nuclear sub HMS Conqueror, marking the opening of hostilities, forced the Argentine Navy to keep almost entirely to port during the war, a major cause of defeat. This shock led to the Argentine Navy embarking on a costly nuclear submarine programme, recognising the power of these weapons in denying activity to enemy ships. The lesson was not lost on Brazil either, who embarked on a parallel programme.[63]

Thirdly, although President Alfonsin ruled out the use of force to recapture the Falklands/Malvinas, Argentina maintained her claim on the islands, seeking diplomatic means to acquire sovereignty. More to the point, the continuing presence of a heavily armed, hostile foreign presence so near to Argentina's shores posed a considerable threat

[63] The Financial Times of 14/1/83 describes Argentina's Post-Falklands re-armament plans thus: "The Argentine armed forces have been re-arming fast since their defeat in the Falkland Islands six monts ago, replacing large amounts of lost equipment and buying the new military hardware which their recent battle experience have shown to be indispensable in modern warfare.

Foreign military experts estimate that Argentina lost about $800m worth of equipment during the war, including a cruiser, a submarine, more than 100 helicopters and fixed-wing aircraft and the entire weaponry of 3 army brigades.

The air force ad fleet air arm took the heaviest losses. New aeroplanes and AA defences constitute the main thrust of the re-armament programme now underway. The first priority was to replace between 40 and 50 Mirage III and Skyhawk fighter bombers shot down by British AA defences and Harrier jump jets ... Another urgently needed replacement was a Lockheed C130 Hercules transport, purchased from the US at the end of last year, to replace a similar aircraft which crashed in Port Stanley during the fighting.

A similar more recent deal involved the Argentine Navy's purchase of 4 Lockheed Electra airliners for conversion into maritime patrol aircraft. The Falklands conflict showed the lack of adequate maritime patrol aircraft to be a major weakness in Argentina's defence ... According to last September's edition of the official air force magazine Aerospacio, the Argentine air force was unable to fly attack sorties on the British task force on 13 of the 45 days between May 1st and the Argentine surrender on June 14 due to lack of information about suitable targets.

During the war, Argentina also learned from the British the strategic value of helicopters as troop transports and airborne weapons platforms for attacking infantry and shipping."

and was a source of disquiet. Despite occasional disputes over fishing rights,[64] relations have improved since then, with diplomatic relations restored in 1990[65]

The effect of the Falklands war can be most simply measured by including a dummy variable for 1982, the year of the war, in the regression for Argentina's military spending, mirroring the 'external war' dummy used in the cross-country work of the previous chapters. Another dummy will be included for 1983, which saw the bulk of Argentina's spending on arms to replace war losses. As far as the continuing presence of the British in the South Atlantic is concerned, this effect is likely to be minor in comparison with other changes that characterised the period, such as the advent of democracy and peace with Chile. It is not possible to distinguish these effects empirically. Nor would it be reasonable to include UK military spending in the equation for Argentina, as only a small proportion of UK military expenditure is devoted to the South Atlantic.

While a threat from a neighbour can be a powerful motivating factor for military expenditure and arms acquisition, military power may also be desired for the purpose of asserting sovereignty over one's territory, and power projection. Major weapons systems may have prestige as well as security value. Naval forces, especially aircraft carriers, can play an important diplomatic role, emphasising the power and importance of their owner in diplomatic missions.[66]

Brazil's military spending can perhaps be most clearly seen in these terms. The most powerful military and economic force in Latin America, Brazil has no border disputes with

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64 LAWR 6/6/86

65 E.g. http://news.bbc.co.uk/hi/english/world/americas/newsid_1196000/1196005.stm, LAWR 2/11/89, 1/2/94, 27/7/99

66 See for example Jane's Defence Weekly 21/6/0, in a feature on Brazil, which contrasts the powerful deterrent and war-fighting capability of the Nuclear Submarine with the peace-time capability of the aircraft carrier in impressing allies, rivals and neutrals alike.

any of her twelve neighbours. She has not been in a war within the region since 1870.[67] Indeed, Brazil has had one of the lowest military burdens in South America for most of the last 30 years.

Nonetheless, Brazil's desire for status as a great power[68], and a position at the world's top tables has been a powerful motive for building military strength. Brazil has at times seen itself as a leader in the developing world, and has used military might, especially naval prowess, as a means of demonstrating this:

"In many ways, Brazil depends on its navy for the achievement of its lofty global aspirations. The Brazilian Navy ... is an important and frequently called upon arm of Brazilian foreign policy. It conducts regular out of area deployments to garner diplomatic support from Third World countries for its initiatives, such as the South Atlantic Zone of Peace." (Jane's Defence Weekly, 23/7/88 p.138)

Similar motives for military spending are not wholly absent for Argentina and Chile, who have for example traditionally asserted claims to dominance in the South Atlantic and South Pacific respectively (Martinus, 1988).

However Brazil's ambitions have rarely been pushed in such a way as to antagonise her neighbours.[69] Nonetheless, Brazil and Argentina long treated each other as rivals and potential enemies, in their quest for regional pre-eminence. They are the only two countries in the region with aircraft carriers, ordered within weeks of each other. (Varas,

[67] See e.g. http://www.onwar.com/aced/nation/bat/brazil/findex.htm

[68] Defense News, September 1987, p. 545, for example comments: "Already a leader in defence production amongst countries in the Third World, Brazil promises to become a major military power by the turn of the century." The SIPRI yearbook of 1980 (p.115) also comments "Brazilian policy can be summarised as aimed at making the country a great regional power both economically and militarily. Success in the latter is probable, in particular with the assistance of West European arms and other forms of military aid."

1985.) Both pursued nuclear, ballistic missile, and nuclear submarine programmes in the eighties and early nineties. The possibility of a conflict between the two was a standard 'war hypothesis' in their respective war colleges.[70] However, they have had no specific border, maritime or ideological disputes which could provide the trigger for conflict:

"Argentina and Brazil, the 2 South American giants, have been perhaps inevitably traditional rivals for political, economic and military dominance in the sub-continent. While this rivalry has historically been conducted on a relatively friendly level ... their interests have been generally incompatible and frequently diametrically opposed throughout most of the 20th century." (International Defence Review, June 1981 "Argentino-Brazil defence accord survives its first year")

Over the course of the eighties and nineties, growing trade relations and military co-operation have rendered the 'war hypothesis' more or less unthinkable.[71] However it is likely that the existence of this rivalry over the years has been an important motive for Brazilian (and Argentine) military spending. We shall therefore test whether the military expenditure of either country has influenced the other's. In particular Argentina is the only country whose military spending can reasonably be hypothesised to have influenced Brazil's.

Brazil's military spending has also been driven by the need to protect and assert sovereignty over a huge land area, border and coastline. The 1990's have seen Brazil make significant military moves to assert sovereignty over the Amazon jungle, in response to the

[69] Martinus (1988), p.166

[70] E.g. LAWR 23/4/87.

[71] In May 1980, President Figuerido of Brazil visited Argentina and agreed joint naval manoeuvres. Brazilian navy minister, Admiral da Silva Fonesca, said on a subsequent visit to Argentina: "a tacit defensive alliance exists between the navies of Brazil and Argentina" (International Defence Review June 1981 "Argentino-Brazilian defence accord survives its first year").

perceived 'threat of internationalisation'.[72] Growing world environmental concern led to campaigners, backed at one stage by Presidents Mitterand of France and Gorbachev of the Soviet Union, to call for the Amazon to be regarded as the 'patrimony of humanity', and even for Brazil to have only 'limited sovereignty' over the region. This led to outraged cries of "A Amazonia e nossa" (the Amazon is ours!) from nationalists and the military.[73] The specific military response came in the form of SIVAM, an air-based monitoring and surveillance system for the Amazon. The Sivam programme, consisting of 300 monitoring stations, 25 radars and 12 aircraft and costing $1.4bn, was announced in 1993, was an assertion of sovereignty and a way of proving that Brazil could protect and manage the jungle without outside interference. It was also of a means of dealing with growing actual security threats, such as drug-dealers, *garampeiros* (gold-diggers) from across the border in Venezuela, and spillovers from the neighbouring conflict in Colombia. It was also a way of exercising control against environmental and indigenous movements, seen by hardliners as a threat to sovereignty.[74]

Except in such specific cases as SIVAM, factors such as prestige and the assertion of sovereignty are hard to quantify; in particular they cannot easily be tracked over time, representing perhaps more a constant 'background noise'. Thus while we may see these as motivations for maintaining a certain level of military expenditure, it is not obvious how they could be proxied in time-series equations.

Overall therefore, while Argentina and Chile have been involved in long-running disputes that may have motivated their military spending, Brazil's desire for military capacity can perhaps be better understood in terms of their desire to assert sovereignty over their huge territory, and to confer regional and global status.

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[72] See e.g. JDW 9/5/92, LAWR 11/7/91
[73] LAWR 5/3/92
[74] LAWR 26/8/93, JDW 21/6/00

5.5.2 Regional interactions – the South American 'Security Web'

In the previous chapters, we estimated demand for military expenditure as a function of, amongst other variables, aggregate military expenditure in a country's Security Web and, as a subset of this, by their Potential Enemies. The latter was found to have a significant and positive effect, while the effect of the former was more ambiguous. For Argentina, Brazil and Chile, their Security Web consisted of their neighbours, while Argentina and Chile were classified as Potential Enemies up to 1984, and Bolivia and Chile throughout the 1981-97 period.[75] This model assumes that countries will respond to the military spending levels of their neighbours, especially hostile ones – in other words, we were looking for effects akin to regional arms races. In this section we examine briefly qualitative evidence for such effects in South America, and other more complex forms of interaction within the region that may affect military spending levels.

The existence of arms races has often been perceived or assumed by many commentators, in South America as elsewhere.[76] While it is not easy to spot year-on-year reactive arms acquisitions, it may certainly be noted that the purchase of new generations of military hardware by one of the main powers in the region has generally been followed in kind by the others over the following few years. Arms purchases by Brazil, Peru, Chile and Venezuela all peaked in the period 1954-56 (SIPRI, 1971), while Argentina, Brazil, Chile and Peru all peaked 1960-61, though it is hard to spot similar patterns of 'spikes' in arms purchases in later decades. As has been mentioned, Argentina and Brazil ordered aircraft carriers within weeks of each other in 1958. Argentina ordered submarines in 1968, and was closely followed by Brazil and Chile. All three ordered fast frigates in the period

[75] Arguably, Peru and Chile could also have been classified as Potential Enemies.
[76] For example Varas (1985, p.1) begins his work: "The arms race in Latin America cannot be analysed independently of the historical structural relationship between the armed forces and the state..."

1969-70. Aircraft display a similar pattern. Argentina bought the US A-4 Skyhawk from the US in 1966-67, which was followed by Chile acquiring British Hawker-hunters in 1969, while Peru responded in the same year with French Mirage 5's, an altogether more advanced plane. Argentina and Brazil also bought Mirages, the IIIE from 1972-73, while Chile acquired more Hawker-Hunters. Brazil stepped up a gear in 1975 with the US F-5 Tiger 2, closely followed by Chile, while Peru bought more Mirage's and MiG-21's second hand from Cuba, while Argentina over the next few years acquired an assortment of Mirages and Skyhawks. Peru took another step up in 1980 with a Soviet purchase, the Su-22, while in 1982 Argentina took the first deliveries of French Super-Etendards, which proved quite effective in the Falklands/Malvinas war, sinking Britain's HMS Sheffield with an Exocet missile. (SIPRI, 1971 and SIPRI yearbooks up to 1983). This type of process might be interpreted as evidence for a regional 'arms race'.

However, reeling off a list of purchases like this does not imply any causal chain from one country's acquisitions to those of her neighbours. Indeed, Varas (1985) believes that the action-reaction arms race model is both too simplistic and too rationalistic to explain the complex security networks in Latin America. Varas stresses the need to consider all aspects of regional and national security from each state's point of view, not just military spending and arms imports by neighbours.

Varas argues that arms purchases are only occasionally a direct reaction to those of rivals. More often, they are a response, not necessarily rational, to changes in the state's security system and perceptions, that threaten the existing balance. Arms acquisitions are an attempt to compensate for this imbalance. They are therefore affected by a complex set of variables, such as changing perceptions of neighbours' intentions, relations with major allies, and internal considerations.

Cuban military spending increases in the sixties, for example, he attributes to disagreements with the USSR leading to fears of isolation from her most powerful ally. (Further increases in the '70s related to Cuba's intervention in Angola and Ethiopia). Similarly in 1971, Chile increased military spending as the advent of the Allende Government lead to fears of an end to US military co-operation. Likewise, Venezuelan military spending increases over seventies may be linked to partial US withdrawal from Central America and the Caribbean, as they increasingly relied on Venezuela to act as their proxy.

Regarding the border disputes involving our case studies, Varas finds that military spending levels may be influenced by perceptions of the rival's intentions and posture, rather than just their military expenditure levels. Chilean military spending increases in 1969 for example, may be more related to the military coup in Peru leading to fears of a more aggressive posture, rather than Peruvian military spending increases. Peru likewise responded to the coup in Chile in 1973 with more weapons imports, and by accepting aid from the USSR. On a somewhat different note, a 1976 'peace move' by Chile and Bolivia to attempt to resolve Bolivia's lack of an outlet to the sea led to increased military spending in Peru, who would necessarily be involved in any relevant territorial changes. As far as the long-running rivalry between Argentina and Chile, Varas only perceives an action-reaction effect in military expenditure levels between 1977-79, as tension over the Beagle Channel reached a height, though this is based only on a cursory look at the data, rather than any econometric analysis.

Internal factors may also be significant. The coup in Chile, along with internal crisis and armed opposition in Argentina from leftist Ejercito Revolucionario del Pueblo led to Argentine military spending increases in the mid 70's. The coup in Chile was also followed in 1974 by big military spending increases. Varas considers that Central

American military spending levels are most closely related to their internal conflicts. A rather different internal motivation is Brazil, where Varas believes their development of a Military Industrial Complex and their increasing push for arms exports, led to increased military spending to help sustain this.

There are signs that with the reductions in tensions, arms race patterns of acquisitions are declining. When in 1996 the US began to consider ending their embargo of high tech weapons to Latin America, Argentina initially objected, fearing that the sale of F16s to Chile would lead to a regional arms race[77], and LAWR of 13/5/97 reports that Chilean officials were trying hard to counter reports in an Argentine newspaper of leaked Chilean military documents which apparently maintained that the possibility of a war with Argentina was still a valid hypothesis. However after the US decided it would lift the arms ban on August 1 1997, LAWR of 12/8/97 reported that Mercusor, the regional trade group including Argentina, had tacitly accepted that this was not a threat and did not represent the beginning of an arms race. And Argentine Defence Minister Dominguez told Jane's Defence Weekly:

"We believe that, in terms of armaments, Chile is now at a balanced policy – it is working co-operatively with Argentina ... their policy has to do with renewing obsolete equipment and not to a re-equipping that may lead to an arms race or an offensive kind of policy. So we do not see any threat to us from them." (JDW 30/4/97, p.40).

Patterns of interaction within a regional Security Web are thus complex, varied, and changeable. Sometimes countries may respond directly to changes in military expenditure and/or arms acquisition by their neighbours, but often it may be necessary to look at other factors, such as changing levels of hostility, fears of a rival's intentions under a new

[77] e.g. LAWR 28/1/97

regime, and insecurity generated by the disengagement of a superpower ally. While it may not always be possible to analyse all these factors empirically, as this would require quantifying them under a common measure, which would be rather arbitrary and ill-fitting,[78] they are nonetheless important for a fuller understanding of the processes driving military spending in particular countries.

5.5.3 Internal conflict

Another significant factor identified in chapter 3 as a determinant of military spending was civil war, a conclusion shared by other studies such as Hewitt (1991). It is therefore worth analysing the degree of internal conflict experienced by Argentina, Brazil and Chile, and to what extent it may have influenced levels of military spending. We start by looking at prevailing attitudes to subversion and internal dissent amongst the military establishments of the region.

Following the Cuban Revolution in 1959, concern amongst Latin American governments and, most especially, on the part of the US, shifted away from 'hemispheric defence' against a Soviet attack, towards the threat of communist insurgency from within. Over the 1960's, the US greatly increased military aid in the form of counter-insurgency equipment to Latin American militaries, while discouraging purchases of sophisticated major weapons for conventional war-fighting.[79] (SIPRI, 1971)

Concern for internal security and cohesion has never been far from the hearts of the continent's militaries. The National Security Doctrine places the military at the heart of the

[78] When we proceed to empirical analysis in Chapter 5, some account will be taken of such considerations, in that a proxy for the level of tension between Argentina and Chile will be included as a regressor for both, alongside the rival's military spending. The democracy index of rivals, as well as the country's own democracy may also be considered.

nation, and insists that all matters relating to 'national power' and 'national objectives' are the concern of the military, not just defence from external enemies. (e.g. Varas, 1985) Any groups which are not pursuing these 'national objectives' are therefore subversive, and this includes left-wing groups which exalt class interests above those of the nation, whether they do so by political or military means. Suspicion has traditionally been high amongst Latin American armed forces of any potential 'enemy within'. Fears of such left-wing threats were often the motivation for military coups, such as Pinochet's in Chile in 1973 against the left-wing government of Salvador Allende, or the 1976 coup in Argentina following perceived failure by the civilian government to tackle left-wing threats. Military take-over invariably led to heavy repression of left-wing forces, which was particularly brutal in Pinochet's Chile and the Argentine *Proceso* from 1976-82, who killed or 'disappeared' over 20,000 people in the course of their 'dirty war' against left-wing insurgents.[80]

Internal conflict, therefore, and even violent or non-violent disorder resulting from internal dissent, could lead to heightened levels of internal military activity, and therefore potentially higher military spending. At any rate preparedness for such intervention could well be a motivating factor for military expenditure in the region.

The two biggest actual internal conflicts in South America in the period considered in this study (1970-2000) have been in Peru and Colombia, which have suffered long-running all-out civil wars with left-wing insurgencies. While these conflicts have had some spillover effects, especially into Brazil, they are not major factors for the three countries under consideration, so a detailed analysis of these conflicts will not be attempted.

[79] It was such US ambivalence about supply, further complicated by Congressional concerns over human rights, that led to many South American countries turning to Europe for military supplies (SIPRI, 1975)

Of the three countries considered, Argentina probably had the most significant insurgency, the Montoneros guerrillas and the Ejercito Revolucionario del Pueblo, which the Heidelberg International Institute of Conflict Research (HIIK)'s KOSIMO database of violent and non-violent conflicts classifies as a 'war'.[81] While most of their actions consisted of what one might call 'urban terrorism' (assassinations, kidnappings, bombings etc.), they also raided military bases and on one occasion sank a naval ship.[82]

Following the military coup in Chile in 1973, the Pinochet proclaimed a 'war' against 'subversive' elements, i.e. left-wing groups, and declared a state of siege which was to last, on and off, till the mid eighties. This was followed up by a brutal crackdown on all opposition. Over 3,000 people were killed by agents of the state during the course of the dictatorship, from 1973-90.[83] The worst abuses occurred in the first four years.[84] The 1991 Rettig Report into the violence generally rejects the idea that the military was fighting a war against a serious armed opposition, describing such armed resistance as minimal.[85]

Opposition to the Pinochet regime, including armed opposition, became more prevalent in the mid-eighties, including an assassination attempt against Pinochet in September 1986. Following this, there were reports of a likely upsurge in violence from opposition groups.[86] However in the years following the coup, the notion of a 'civil war' propagated

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[80] Encarta Encyclopedia, "Argentina's general resources and history" at http://www.shadow.net/~giorgio/argentina.html.
[81] http://www.conflict.com/hiik/query_country.asp
[82] http://www.wikipedia.com/wiki.phtml?title=Montoneros
[83] Report of the National Truth and Reconciliation Commission, Raul Rettig, March 1991, found at http://www.lakota.clara.net/derechos/resour.htm#rettig. English translation of parts of report at http://www.derechoschile.com/basicos/ddhhchile/rettig/english/rettigengindex1.html. See also LAWR 14/3/91. The Rettig report into human rights abuses found that 164 deaths during the Pinochet era were due to 'political violence', mostly armed clashes. Of the rest of the deaths, classified as human rights abuses, about 90 were not down to agents of the state. Six percent of the victims were police or military personnel, the rest civilians, of whom half had a left-wing connection, half had no record of political activity whatsoever. The death toll estimate was initially 2,298, later increased to 3,197 – see LAWR 5/9/96
[84] E.g. Countrywatch.com entry for Chile Political History at http://www.countrywatch.com/cw_topic.asp?vCOUNTRY=36&SECTION=COVER&TOPIC=POHIS&TYPE=TEXT.
[85] Rettig Report, as above.
[86] LAWR of 2/10/86 reported that the Communist Party, the Frente Populare Manuel Rodriguez (formed in 1983) and the Movimiento de Izquierda Revolucionaria (MIR) were preparing a major offensive against the

by supporters of the regime would seem to be fanciful; however the military action under Pinochet was certainly on a scale as if there was a civil war.

Brazil, though riven by economic and social divisions, crime and drugs problems, has not had any internal armed conflict in the period under consideration (or indeed for some time before), though recent years have seen some level of political violence.[87] Organised crime, frequently drug-related, has also draw a military response, with a 1994 army operation against criminal gangs based in the *favelas* of Rio, a move widely supported by the public.[88] The military was also used in the late eighties to break strikes.[89]

While Argentina, Brazil and Chile have all, therefore, seen violent internal conflict in one form or another, the type of conflict has not been of the sort where one would expect large outlays on sophisticated weapons systems, or even on major counter-insurgency weapons, such as would be required by the wars in Peru and Colombia. Nonetheless, the type of brutal crackdown seen in Argentina and Chile, though on unarmed civilian opposition, implies a high degree of militarisation of society, which may therefore call forth extra resources for military (especially army and paramilitary police) recruits, and for salaries and conditions that would ensure their loyalty. However it would be more reasonable to see this as caused by the presence of an authoritarian regime, rather than by internal conflict *per se*. Overall therefore, it is doubtful as to whether the specific conflicts experienced by these countries could have caused significant variations in their military spending levels – though the military's desire to be able to intervene should they see fit

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regime. This was to include direct military attacks (suggested by arms finds, including M16 rifles, such as were used in attempt on P's life), creating militias and self-defence committees in poor neighbourhoods – barricades, trenches and molotov cocktails had proved quite effective against normal patrols, and weakening military and police unity by encouraging desertion and trying to persuade troops not to fire on the people.

[87] The MST (Landless People's Movement) staged from the 1990s a growing campaign of generally peaceful land occupations, which were met with violent responses by armed groups hired by the landowners, and sometimes by troops. E.g. LAWR 5/10/95. There has also been violent right-wing action against environmental movements and indigenous people's groups, most notoriously the murder of Chico Mendes in 1988. Some sections of the military suspected the MST of having a more sinister subversive agenda, accusing them of links with the Peruvian Sendero Luminoso, e.g. LAWR 5/10/95

[88] e.g. LAWR 8/12/94, Hunter (1996)

and to respond to internal dissent when in power may well have been a constant factor sustaining military spending levels. Given the number of variables that could potentially be included in modelling demand in these countries, it therefore does not seem appropriate to attempt to proxy levels of political violence as part of the estimations.

5.5.4 New Missions

We have discussed external and internal conflict, and the threat thereof, as likely drivers of military spending. Protection against such threats is the 'good' traditionally purchased by the state through military spending, whether on behalf of the people or on its own behalf. More recently however, new roles and missions have been discussed as possible reasons for military spending. This took place in the context of the end of the Cold War, the reduction of regional tensions, and the transition to democracy of most Latin American nations. A great deal of discussion ensued as to the role of the region's militaries in the new international environment, with the Soviet threat gone, as was (in all but Peru and Colombia) the threat of communist insurgency. Intra-regional "War Hypotheses" had also vanished or greatly diminished. What then was the point of the military? Brazil perhaps engaged in the most soul-searching in this regard. (e.g. Hunter (1996), LAWR 21/8/86, 10/12/92, Guardian 8/7/91, Latin American Newsletters (LAN) Special Report December 1998) Possible new missions that came out of this included international peacekeeping, narcotics interdiction and civic action, which we shall now briefly discuss. These can be seen as additional goods and services that may be purchased by military spending, and therefore as potential new determinants of demand.

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[89] LAWR 4/2/88, 8/12/88

Peacekeeping has been especially important for Argentina, who by 1997 had sent 9,458 troops on peacekeeping missions around the world.[90] Indeed, according to Foreign Minister Dominguez in 1998[91], Argentina was only interested in purchasing new equipment that would further their peacekeeping activities. The US has been particularly keen for Latin American militaries to participate in anti-narcotic operations, but this has met with a cool response from South American governments and militaries, the latter seeing this as police work (Hunter, 1996). The Brazilian army did launch one major operation in 1994 however, occupying the *favelas* of Rio to root out drug dealers. Civic action, that is work by the military on development projects, has some tradition in Brazil, and was revived by the 1992-94 Franco government (Hunter, 1996). Although there are advantages to both government and military in this arrangement: the government achieves social objectives while keeping the military occupied, and the military gains popular support and additional budgetary leverage, significant downsides mean this has never been a significant role. For the government, the military is given a dangerously prominent internal role, while the military feel their professionalism is compromised by such mundane work. (Hunter, 1996).

Thus with the exception of peacekeeping for Argentina, these new missions were minor factors, unlikely to provide significant new calls on resources. Furthermore, the reasons for seeking such missions can in many ways be seen as political – the fact that there were bureaucratic and political limits to the rate at which military spending could be cut, especially given the continuing influence of the military in many cases. In this sense these new missions were not of themselves new drivers for military spending, rather they were new ways of using military resources that for political reasons had to be maintained. While noting the importance of these issues as part of the discourse on Latin American militaries

[90] JDW 21/5/97
[91] JDW 9/12/98

in recent years, we shall not therefore seek to model these new missions as part of a demand function.

5.5.5 Summary

Overall, what emerges from this analysis is that external defence and power-projection have been the primary justifications for military spending by Argentina, Brazil and Chile. Argentina and Chile have maintained military preparedness on account of their long-running rivalry; Chile also has disputes with Peru and Bolivia, while Argentina engaged in armed conflict with the UK. The changing parameters of these disputes over time, as well as the levels of military spending by the rival in question, may be important in understanding military spending variations. Brazil on the other hand has probably been more concerned with the relatively constant factors of asserting sovereignty over her vast land area, and bolstering her status as a regional and potentially global power – though regional rivalry with Argentina cannot be wholly discounted from the equation for either of the two.

The militaries of all three countries, in common with others in Latin America, have traditionally upheld a secondary mission – of defending the country against internal threats, mainly from the left, including non-violent political movements. This may well have been a factor in maintaining a sizeable military establishment, but it is doubtful whether the actual conflicts that have taken place within any of these three has been of sufficient scale to significantly affect military spending levels.

New missions such as peacekeeping and narcotics interdiction are probably of marginal significance in themselves, but may indicate the military's ability to command continuing funding, despite the vanishing of the traditional threats that have justified their existence in the past.

5.6 The political dimension: military rule and democratic transition

5.6.1 Introduction

The results of chapters 3-4, and other cross-country studies such as Hewitt (1991) and Rosh (1988), show a clear negative impact of democracy on military spending, a result shared by the regional panel for Latin America. Another study of Latin America, Lebovic (2001), shows in a pooled data study of 13 Latin American countries from 1974 to 1995, that a democracy index has a significant positive effect on the year-on-year change in government budget share of civil spending in relation to military spending. The model also includes a variety of economic variables, and a dummy for war (external or civil). Country dummies are included where significant, making the model in part a fixed-effects model. Looney (1986), looking specifically at Argentine data in the 60's, 70's and early 80's, shows military regimes clearly spending more on defence than civilian governments.

One does not have to look far for reasons this might be the case. A powerful military may be needed to suppress rebellions against military rule, and very often to suppress peaceful forms of dissent. Even in the absence of strong organised opposition, the government may desire to project a powerful presence to the populace, to ensure their compliance. Furthermore, the government will want to ensure the loyalty of the armed forces on whose support they depend, to reward their co-operation with increased salaries and the latest equipment. Apart from this, they may simply wish to use their political power to reward their own people. Externally, a civilian government may be inclined to take a less militaristic stance towards international issues – for example Argentina's new civilian

President Alfonsin was keen to rule out military force as a means of resolving territorial disputes with Chile and the UK. (Martinus, 1988).

These considerations may be viewed from two perspectives: on the one hand, a military government's perception of security needs, both internal and external, may be greater than that of a civilian government. On the other hand, the military may be able to use their institutional and physical control to engage in rent-seeking behaviour, extracting material rewards for the military institution and its allies. This may take the form of higher salaries, of prestigious weapons systems beyond the needs of external defence, or profits from industries placed under the control of the military, such as the defence industry in many cases, or Chile's copper industry.

Thus we may reasonably hold a prior expectation that we will find a negative coefficient of democracy on military spending in our equations for these three countries. However this section will argue that the relationship is neither certain nor straightforward: the military may retain considerable power and influence following a handover of power to civilians, restricting the new government's freedom of action in relation to military budgets and other issues. Thus, the military's rent-seeking capabilities do not necessarily end with the formal transfer of power. In seeking to understand the effects of political change in our case studies, we must, therefore, look at the differing experiences of transition to democracy on the part of these countries in the 1980s, and the resulting degree of influence retained by the military post-transition. This is done in section 5.6.2. Furthermore the size of the budget may be only one of many issues of contention in civil-military relations, so that military expenditure levels may potentially be an outcome of the overall strategy adopted by the new government towards the military. We examine these issues in section 5.6.3. Section 5.6.4 concludes.

5.6.2 Transition to democracy and continuing military influence

During the 1980s, Argentina, Brazil and Chile all experienced transitions to democratic civilian rule which, with the advantage of hindsight, have the air of permanence. (Argentina's military also handed over power in 1973, though this turned out to be short-lived, with the military retaking power in 1976). This echoes a process that has taken place throughout Latin America, where all countries are at least nominally ruled by civilians.

However this common factor conceals wide-ranging differences in the circumstances of the transitions, and the nature of civil-military relations thereafter. With a long history of interventions, military establishments have rarely been content to accept a western-style role of unconditional obedience to the civil authority. The degree of continuing involvement in internal affairs and institutional autonomy of the military under civilian rule has varied greatly both across countries and across time. We look more closely now at the nature of the transition in each country, and then discuss the implications for the military's ability to command budgetary outlays.

The military regime in Argentina collapsed following the Falklands defeat in 1982, and left power in disgrace and humiliation, having committed massive human rights abuses, brought about economic recession, and lost a war (e.g. Hunter (1996)). The pledge by the incoming Alfonsin government to curb their power and cut their budget therefore seemed in tune with public opinion. (E.g. Fitch, 2000 p. 77). The military themselves were heavily demoralised, and in no mood to consider attempts to regain power, even in the event of politics taking an unfavourable turn.[92] While the Alfonsin government cannot be said to have had a free hand with the military, it was in a very strong position.

[92] For example Fitch (2000), p. 73, quoting Argentine officers in a survey of military role beliefs, includes from one officer: "[The lessons are] never to return again to power, even if the country disintegrates internally … If [there is] a bad government, let the citizens go to the Plaza de Mayo. Let them settle it. Let

The Pinochet regime in Chile, on the other hand, was able to leave power with a great deal of the military's power intact. The constitution bequeathed to the new civilian government which took office in 1990 contained numerous 'institutional safeguards' to guarantee the continued influence and autonomy of the military. These included a supreme court dominated by Pinochet appointees, nine designated Senators, including armed services representatives, and in fiscal terms, 10% of sales of the state copper company Coldeco to go to the military for arms purchases, and a military budget floor equal to 1989 budget. Pinochet himself remained head of the army until 1998, and the President would have no power to hire and fire armed services chiefs. (e.g. LAN Special Report December 1998). These measures ensured both that the armed forces could pursue their own agenda internally, and also that they maintained influence on non-military politics. In particular, the designated senators enabled them, in alliance with the political Right, to hold sway on many issues in the legislature.[93]

On the other hand, the Pinochet regime did not go entirely voluntarily, but after losing a 1988 referendum on Pinochet's continued rule.[94] In the subsequent elections, a Centre/Left coalition defeated the right-wing candidate for the presidency. Furthermore, military rule had bitterly divided Chilean society. One of the first acts of the new Aylwin government was to institute a Truth and Reconciliation Commission to establish the extent of abuses.[95] While the military could get their way in the Senate to defend their position, they could not always expect a sympathetic ear from the government when it came to issues such as the budget.

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the armed forces never [again do so]." And another: "The armed forces have learned that the worst civilian government is better than the best military government."

[93] News reports for the subsequent period shows army chief Pinochet and the military in general able to re-organise deployments, conduct foreign visits (while making overtly political comments), all without consultation with the civilian government and on at least one occasion mobilising troops in response to tensions with the government. E.g. LAWR 15/2/90, 13/12/90, 30/5/91, 10/6/93,

[94] LAWR 3/11/88

[95] LAWR 3/5/90

The Brazilian military was in some ways in a weaker position than the Chilean, in other ways a stronger one, when they handed over power in 1985. On the one hand they had much fewer 'institutional safeguards' than their Chilean counterparts, though they retained three separate armed forces ministers in the cabinet and military representation on other important bodies.[96] On the other hand, they left power in a process designed entirely by themselves.[97] There had been much fewer human rights abuses in Brazil[98] than in Chile or Argentina, and the military was therefore much more popular than in Chile. While they had less formal capacity to influence civilian politics, there were much fewer causes of conflict with the new regime. The Brazilian military explicitly reserved the right to intervene again if the government failed to control the country.[99] While the new 1988 Constitution removed their absolute right to intervene, it allowed them to do so if requested by any single 'constituted power'. A Latin American Weekly Report headline of 15/9/88 (p.1) sums up the relative position in Brazil and Chile: "Brazil's military gain quietly what Pinochet demands loudly".

The position in Brazil and Chile fitted the pattern of what Fitch (2000) describes as 'military tutelage', with the military enjoying internal autonomy and strong influence over a nominally democratic regime. Argentina's was closer to full civilian control.[100]

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[96] LAWR 15/9/88

[97] LAWR of 19/11/87 (p.9) Quotes Stepan(1988) thus: "The military relinquished their control of the presidency only after intense informal negotiations that left many military prerogatives unchallenged. Indeed, in the 12 years between 1973 and 1985, the military was able to reconstitute its internal hierarchy and create new capabilities to manoeuvre within a more open political system. Because direct presidential elections have not yet been held in Brazil, because the military retains so many prerogatives and powers, and because the civilian president, Jose Sarney, uses the military as a critical part of his power base, the Brazilian transition is in fact far from complete. Indeed ... some people question whether the "New Republic" that began in 1985 yet warrants classification as a democracy."

[98] E.g. LAWR 26/3/87

[99] E.g. JDW 9/5/92, p.810, Brazil country survey, "The armed forces have reserved the right to return to the political arena if civilian governments fail to get a grip on the country's problems.", LAWR 5/1/89

It is natural to suppose that military budget cuts are more likely to follow a democratic transition where the military is weak and demoralised such as in Argentina, than where it retains considerable power and influence such as in Brazil and Chile. The Argentine military could carry no credible threat of seizing power again; except under the most extreme of circumstances any such attempt would be opposed by large swathes of the military who, following the experience of the 1976-83 junta saw military rule as something never to be attempted again.[101] They retained no institutional control over the workings of government, and the new Alfonsin regime had a popular mandate to reduce their influence further. Thus the capacity for the military to exact economic rent was drastically reduced.

In Chile, by contrast, the military retained a strong hold over civilian policy through the institutional privileges described above. The budgetary floor for the military and the 10% of copper profits may certainly be seen as a form of rent extracted from Pinochet's ability to write the constitution in 1980 – while the other institutional constraints ensured these fiscal privileges could not easily be overturned.

As noted, the military's institutional control was less in Brazil than in Chile. But they were perhaps more able to wield the implicit or explicit threat of intervention if political developments were not to their liking. Furthermore, the use of the military on many occasions by the government to break strikes and tackle drug dealers in the 80's and 90's ensured continuing acceptance of the military's role in internal affairs. (Hunter, 1996, various LAWR reports). There are fairly blatant examples of how this situation could be exploited by the military for rent-seeking purposes: in 1988, a captain invaded a town hall

[100] Fitch considers that in Brazil the degree of military tutelage has lessened gradually but considerably since the restoration of democracy in 1985.
[101] As is born out by Fitch (2000)'s interviews with serving and retired military officers.

demanding higher pay; he was arrested, but a pay rise followed within *hours*[102]. In 1992, a bomb in Brasilia by someone claiming to be a disgruntled member of the armed forces[103] also procured a pay rise. In 1994, when President Franco refused a pay rise that Congress had awarded themselves, in response to military anger about their own pay, one colonel said: "If Brasilia's armoured brigade were to go completely mad and surround the congress building with its tanks, the entire city would back it."[104]

An initial analysis of the data gives some support to the idea that where the military retains greater institutional power they will do better financially: military spending dropped sharply in Argentina after 1984, while it continued to rise, albeit more slowly after transition, in Chile, and also rose in Brazil after the hand-over, where it had previously been falling. Of course this does not take account of the various economic and other factors at work in these countries. Also, the fact that the military share of GDP fell under democratic rule in Chile, where the military retained most institutional power, does not bear out the pattern. It may be necessary to consider more complex sets of priorities and interactions to understand how democracy has affected military budgets, which we examine in the next section.

5.6.3 Post-transition political strategies by and towards the military

The level of military spending may not be the only issue of contention between the government and the military post-transition. Others include military influence in internal affairs, human rights prosecutions, and civilian control of the military. Neither party could get their way on everything; even in Argentina, Alfonsin's policies against the military eventually led to a series of mutinies. (e.g. LAWR 7/5/87, 27/8/87, Fitch 2000). On the

[102] LAWR 4/2/88
[103] LAWR 14/5/92
[104] LAWR 31/3/94

other hand, even a powerful military such as that of Brazil or Chile could not wield the threat of coup or mutiny over every disagreement without losing popularity and credibility. Trade-offs may therefore exist for both the military and the civilian rulers between various different goals. Thus, while for political and/or economic reasons, a civilian government may wish to cut military spending or contain its growth compared to what military rulers would do, this may not be their only or even their most important priority, and it may conflict with other objectives. It is this balancing of priorities between the civil and military powers that we consider in this section.

A particularly important area we shall look at is the civilian government's strategy, if any, of ensuring that the military accepts subordination to civilian authority. Hunter (1996) identifies objective and subjective control as two essential alternatives:

"Latin America's civilian governments have a choice of two strategies to keep their militaries in check. Subjective control reins in military ambitions in the domestic sphere by actively subordinating the armed forces to the control of the government and other civilian groups. The more effective method of objective control attempts to keep the military out of politics by 'buying it off' through increased defence spending and an emphasis on modernisation and professionalisation." (Hunter, 1996 Introduction, p. 8)

A government wishing to pursue a strategy of "objective control" for example, may need to be willing to fund new missions, new equipment and modernisation programmes in order to get the military to buy in to a new political order of subordination to civilian authority. Thus the choice of strategies may have important implications for military spending levels.

In Argentina, the government of President Raul Alfonsin that took over from the military in December 1983, can reasonably be described as pursuing a strategy of 'subjective control' towards the military – a course of action made possible by the political weakness of the military following the Falklands/Malvinas defeat. They instituted a civilian ministry of defence, responsible for military budgets, defence production, logistics and defence policy, all previously controlled by the service chiefs. The military was also removed from management of arms companies. The 1988 National Defence Law removed the military from an internal security role. The military budget was cut heavily, and personnel reduced. (Hunter 1996). The weakened, demoralised military was in no position to resist this.

Perhaps most grievous for the military were human rights trials which imprisoned several leaders of previous military juntas for crimes committed during the 'Dirty War'. In addition, the armed services chiefs from the Falklands/Malvinas war were imprisoned for losing the war, including former President Galtieri.[105] This was followed by further trials of high and middle-ranking and eventually junior officers.[106]

This antimilitarist *blitzkrieg* certainly shattered the institutional power and political influence of the military, but the combination of low pay and human rights trials led to a backlash, with three mutinies in 1987 and 1988, and another under Alfonsin's successor, Carlos Menem in 1990.[107] Although the mutinies were ended in fairly short order, there were rumours of behind-the scenes deals, and several months after the first mutiny in Easter 1987, a law was passed exempting junior officers from human rights prosecutions if they had acted with 'due obedience'.[108]

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[105] LAWR 23/5/86
[106] E.g. LAWR 16/4/87

[107] LAWR 7/5/87, 4/2/88, 22/12/88, 13/12/90, Fitch (2000) etc.
[108] LAWR 18/6/87

The mutinies served as a warning to the government that there were limits to how far they could antagonise the military; however the payback did not come in the form of increased resources. President Menem, who took office in 1989, satisfied the military's most serious grievance in 1990, by ending human rights prosecutions and pardoning all those convicted of human rights violations. [109] Menem also practised a measure of 'objective control' in the form of giving the military a strong peacekeeping role, improving their professional status and international credibility, and also leading to higher pay. But the military did not gain much in budgetary terms. They suffered a large budget cut in Menem's first year in office, and whereas military spending stabilised thereafter, it continued to fall in relation to GDP as the economy grew. Meanwhile, Menem used his more harmonious relationship with the military to ensure their co-operation on other issues: Menem privatised military industries and forced the military to end the Condor II missile programme[110]. In 1993 Argentina signed the 1967 Treaty of Tlateloco, banning nuclear weapons from South America[111], and joined the Missile Technology Control Regime[112]. Conscription was abolished in 1994.[113]

Military complaints about the budget were frequent,[114] but did not prevent Menem from enjoying a reasonably good relationship with the military, as their acceptance of the above changes show. If Menem's policy can be described as objective control, as Hunter (1996) tentatively does, it was bought not so much with money as with the pardoning of human rights convicts and the end of prosecutions, and with that greater institutional esteem.[115]

[109] LAWR 19/10/89
[110] LAWR 30/5/91
[111] LAWR 25/11/93
[112] LAWR 9/12/93
[113] LAWR 23/6/94
[114] E.g. LAWR 30/5/91, 9/10/91, 23/7/92, 3/6/93, 23/6/94, 6/10/94, 10/11/94, 31/8/95,4/7/96, 25/3/97. At one stage there were reports that forces were renting out barracks for birthday parties and growing their own vegetables!
[115] Fitch (2000), p.79 sums up the position: "President Menem pledged to put an end 'the military problem,' pushing through an amnesty, which ended the trials, and later issuing a pardon for the convicted members of the juntas. Military salaries fell again and then recovered, but military spending dropped from 3.5% of GDP in 1989 to 1.9% in 1991. Nevertheless, when challenged by another *carapintada* uprising in 1990, Menem demanded and got swift military action to smash the revolt. Although the military's budget problems have

The general weakness of the military meant they did not fare well financially under either civilian president. At first sight this was most significant under Alfonsin; but this must be set against the parlous economic situation the country faced during the Alfonsin years, with a stagnant economy, the debt crisis, and bouts of hyperinflation. By contrast, the Menem administration was a period of economic stability and growth, but during which military spending first suffered a heavy cut in 1990, then did no more than bump along the bottom. By giving way on human rights trials, Menem was able to maintain a hard budgetary line.

Brazil perhaps matches more closely the pattern of 'objective control' set out by Hunter (1996). After a fairly pro-military administration under the first civilian President, Jose Sarney, his successors gradually brought the military under greater civilian control, while increasing their budget and granting them significant roles in the Amazon and elsewhere, with modernised equipment to fulfil them.

According to Fitch (2000), President Sarney, the first civilian president, used the military as part of his power-base. The cabinet included 6 ministers of cabinet rank, including the three armed services ministers. In the process leading to the Constituent Assembly drawing up a new constitution in 1988, Sarney was frequently favourable to the military's goals.[116]

Since President Sarney left office in 1989, the power of the military has been reduced. Sarney's successor Fernando Collor appointed a civilian head of the state intelligence agency (reducing the military's cabinet tally by one), and forced the military to end their

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worsened, Menem seldom misses an opportunity to socialise with the military or to praise their patriotism and professionalism. The contrast with Alfonsin in symbolic terms could scarcely be greater. As a result, nuclear weapons programme. Before this, the constituent assembly had approved an unconditional right to strike and made frequent 'raids' on the military budget, using their prerogative to transfer funds from one budget to another. (Fitch 2000). Summarising this process:

"In 1990 Fernando Collor … started dismantling the military entrenchment within the Presidency of the Republic. He dissolved the National Defence Advisory Secretariat and the National Intelligence Service (SNI), structures that had been created during the military dictatorship. In 1992, the forces submitted to another difficult test: they witnessed, without a blink, President Collor's impeachment and ejection from the government amid accusations of corruption." (JDW 21/6/00, p.22)

In 1996 President Cardoso established Brazil's first (civilian-controlled) "defence policy", and in 1998 he established a Ministry of Defence, with a civilian head. In 2000, a first ever defence white paper was published. The Military co-operated with these changes.[117]

The flip side of this was that the military were rewarded with an increased budget and modernised forces (Congressional 'raids' notwithstanding). Military complaints about pay and funding in general are frequent themes in news reports,[118] but the civilian powers were quite keen to at least partially satisfy the military on these counts[119]. As noted above, occasional acts of violence by rogue military elements were rewarded with immediate salary rises. As our data shows, military spending rose steadily both in real terms and as a share of GDP following the transition to democracy in 1985.

Menem gets generally favourable or mixed ratings for his treatment of the military, despite the lack of budgetary payoffs, compared to the overwhelmingly negative evaluation of Alfonsin's military policies."

[116] LAWR 15/9/88

[117] JDW 21/6/00

[118] E.g. LAWR 30/10/86, 12/2/87, 5/11/87, 19/1/89, 29/11/90, 18/7/91, 22/8/91, 10/10/91, 14/5/92, 27/5/93, 31/3/94, .

[119] e.g. LAWR 4/2/88, 20/10/88, 18/7/91, 14/5/92 27/4/93, 31/3/94

In addition, the military was given a prominent role both internally and externally. The Calha Norte project announced in 1985, according to Hunter (1996, p.23), "essentially put four thousand miles of Brazil's border under military jurisdiction." The SIVAM project, described in previous sections, gave the military a key role in controlling and to some extent developing the Amazon. Civilian rule was followed in short order by the FT90 plan for modernising the Brazilian armed forces. (JDW 9/5/92). Projects for domestically produced nuclear-powered submarines and aircraft carriers continued. (JDW 21/6/00). All this proceeded despite the abandonment of 'war hypotheses' with Argentina and other neighbours, and the end of the Cold War which also lessened fears of Communist subversion.

Clearly the government could not completely satisfy the military, but discontent over low pay was not something they could ignore. The case can be made that financial rewards were used to buy the military's gradual subordination to civilian control.[120]

The situation in Chile is somewhat different, in that the civilian government was not in a position to exercise any sort of control, objective or subjective, over the military. Pinochet's 1980 constitution[121] had set up powerful institutional walls protecting the autonomy of the military, which were jealously guarded. (e.g. Hunter, 1996).

The biggest point of conflict between the two powers seems to have been the issue of human rights investigations. 'The day they touch any of my men will be the end of the state of law' said Pinochet in October 1989.[122] Once in power, Aylwin was quick to set up the Rettig Commission to investigate human rights abuses in the Pinochet era, despite amnesty laws preventing prosecution of military officers for human rights offences. The

[120] Investigations and prosecutions for past human rights abuses, an issue in Argentina and Chile, were not pursued in any way by Brazil's civilian rulers.
[121] Amended in 1988, somewhat against the military's interests, but leaving most of the privileges intact.

military strongly opposed these investigations.[123] Of the various 'institutional safeguards' left in place by the Pinochet regime, the one the new governments seem to have been most eager to get rid of was the law preventing the President from hiring and firing armed services chiefs. Both Presidents Aylwin and Frei brought bills to change this. (Unsuccessfully.)[124]

On the other hand, there is little evidence from any of the sources used in this study[125] of significant conflict over the budget. Set at a minimum of the 1989 levels, and with the additional guarantee of 10% of the turnover of the state copper company for arms purchases, military expenditure did not rise much above this level during the 1990's, while the economy grew strongly and steadily. As our data shows, the military share of GDP fell from 5% in 1989 to just over 3% ten years later. It is hard to draw conclusions from a negative, but it is at least possible that the military were fairly satisfied with the generous minimum they had guaranteed themselves before leaving office, and considered defending their institutional privileges and preventing human rights prosecutions more important.

5.6.4 Summary

Democratic rule has been consistently shown by many studies to lead to lower levels of military spending. Military governments in particular are likely to have greater threat perceptions internal and external, but may also use their institutional control and monopoly of armed force to exact an economic rent for themselves and their allies. However this rent-seeking capability may not disappear upon the restoration of democracy. In Argentina, the military's weak position meant the government could slash their budget as well as restricting them on other fronts. In Brazil however, the military

[122] LAWR 26/10/89
[123] E.g. LAWR 16/8/90, 8/4/91, 21/7/94,
[124] E.g. LAWR 28/7/94

remained powerful and the threat of intervention enabled them to continue to reap financial benefits. In Chile, the military's continuing rent-seeking ability depended more on their past institutional control, enabling them to leave behind a highly favourable constitution and political means to defend it.

We also see a different pattern of political interactions and priorities between the government and the military across our three countries, and sometimes between different governments within the same country. In Argentina, Alfonsin tackled the military on all fronts, running into trouble in the form of mutinies; his successor Menem gave way on human rights prosecutions, but continued to squeeze the budget and enforce military subordination to civilian control. In Brazil, a much stronger military were financially rewarded in return for accepting increasing civilian control. Human rights investigations were not pursued at all. In Chile, the powerful military defended their institutional privileges and autonomy, but seemed reasonably content to accept a fairly static budget, around the constitutionally guaranteed minimum, as the economy grew.

Many of these factors are difficult to measure empirically over time. The measure of democracy we have been using from Polity 98 data certainly marks the transitions between military and civil rule, but does not really capture the continuing influence of the military post-transition. One possible approach is to use dummy variables for different civilian administrations; in the case of Argentina this makes some sense, given the very different approaches to the military taken by Menem and Alfonsin; the brief Peronist administration in the 1970s faced very different circumstances again. In Brazil, it might be reasonable to distinguish between the pro-military Sarney administration and the more reformist presidents thereafter. However the main value of the analysis in this section is that it helps

[125] Latin American News, military press such as Jane's Defence Weekly, Hunter (1996), Fitch (2000)

us understand the differences between the three countries, and why their transitions to democracy may have had quite differing effects on military spending.

5.7 Conclusions

We have investigated the security, economic and political dimensions influencing military expenditure in Argentina, Brazil and Chile. The security dimension includes long-running disputes between Argentina and Chile, and between Chile, Peru and Bolivia. For Brazil, the security dimension consists mostly of the need to assert sovereignty over such a large area, and the desire to project power regionally and globally – a motive shared to a lesser extent by Argentina and Chile. Internal conflict seems a much less important component of the security dimension, though the preparedness of the military to take control when they see necessary may have been a factor determining the historic size of the military.

Levels of economic growth and the debt crisis represent important economic constraints on any form of expenditure, but it may be possible for an institutionally powerful military to insulate itself from the worst effects of economic problems to some extent. Inflation is another factor which may, again partly for institutional reasons, affect military spending levels through administrative lag.

Consideration of the political dimension means we may have to consider a rent-seeking aspect to military expenditure in conjunction with our baseline utility-maximisation model. The institutional power of the military and their monopoly of armed force may enable them to exact a rent, an ability that does not necessarily disappear with transition to civilian rule. The effect of transition will depend partly on the circumstances thereof, especially the level of residual military influence, and may depend partly on the political strategy of the new government towards the military.

6. Data and empirical results for Argentina, Brazil and Chile

The last chapter explored the economic, political and security environments of Argentina, Brazil and Chile, identifying a wide range of factors in all three dimensions that could influence military spending. We identified economic factors likely to be significant in all three countries, such as national income, debt and inflation; security factors varying from country to country, principally the Argentina-Chile and Chile-Peru rivalries, the Falklands/Malvinas war and Brazil's ambitions as a regional and global power; and political factors relating to military rule, transition to democracy and subsequent patterns of civil-military relations. These political factors in turn could potentially condition response to economic factors, as a powerful military may be able to shield itself from economic fluctuations. In this chapter we will attempt to apply these insights by estimating time-series equations for the demand for military spending in the three countries, seeking to quantify as many of these factors as possible. We shall attempt to relate different patterns of demand in the three countries to their different political and strategic circumstances.

Section 6.1 describes a generic empirical model of military expenditure for the three countries. Sections 6.2-6.4 present and estimate specific models for Argentina, Brazil and Chile based on the generic model and the particular circumstances of each country, and section 6.5 briefly compares and contrasts these results, and concludes. Appendix 5 presents an alternative approach to the demand for military spending in Argentina and Chile, estimating a co-integrating VAR arms race model. Appendix 6 presents some preliminary results on the demand for major conventional weapons in Argentina, Brazil, Chile and Peru.

6.1 A generic empirical model for military spending in Argentina, Brazil and Chile

In chapters 3-4, we assumed a utility maximisation model that expressed military expenditure as a function of economic, political and security factors: national income is divided between military and civil expenditure according to the level of threat faced, external and internal, and political factors affecting the government's perception of relative priorities. The empirical model used, involving variables such as total Security Web military spending, was suitable for comparing a large and heterogeneous set of countries by a common set of measures; when we come to the level of individual countries however, it is likely to prove more fruitful to develop measures that reflect the peculiar circumstances of the countries concerned.

There is also a difference in the underlying theoretical approach. In particular we have argued that in the context of South America the utility maximisation approach may need to be complemented by an institutionalist approach, whereby military spending may be at least partially a form of economic rent extracted by an institution with a monopoly of armed force and varying degrees of political control. We may expect this institutional component to be a function of economic and political variables, but perhaps not security variables to the same degree. Economic variables will relate not so much to a rational allocation of total available national resources, but to factors that affect the political-economic position of the military. Overall, we may expect most of the same variables to appear as if we were using a purely utility maximisation model, but our interpretation of their meaning may be somewhat different.

It is not the aim of this chapter to develop a detailed mathematical demand model that would incorporate the institutional considerations discussed, in the context of changing civil-military relations in the three countries – though such a model would be a very interesting topic for future research. Rather, we seek to draw upon the insights of the previous chapter to construct a suitable set of variables that are likely to be important in determining demand for military expenditure, so as to produce an estimable demand function. We therefore look in turn at each of the three dimensions – economic, political and security - describing the variables that will be used in estimating demand for military spending for our three countries.

It is in the security dimension where the relevant variables will be the most country-specific. We shall use the military spending levels of each country's most significant neighbours as independent variables: Chile and Brazil for Argentina, Argentina and Peru for Chile, and Argentina for Brazil. In the case of Argentina and Chile, we shall also attempt to proxy the level of tension between them over their long-running border disputes, as this was something that varied considerably over the period in question. Dummies will also be included for significant events such as the Falklands/Malvinas war.

It is not however practical to proxy all the changing security relationships involving these countries, of the sort discussed in the last chapter; this would lead to an excess of variables, many of them referring to overlapping periods, so that it would become very difficult if not impossible to separate out differing effects. We can only hope to pick out what seem to be the most important developments from the point of view of their likely effect on military spending. Thus for example, in accordance with the discussion of the last chapter, we have chosen not to include a variable for the level of political violence in each country.

Turning to economic variables, the level of GDP will be included for each country, current and lagged. In the previous chapters we found military spending to be roughly proportional to national income. If the utility maximisation explanation of military spending is broadly correct, we would expect a fairly similar result. If military spending is better explained as economic rent, we might find a much weaker dynamic relationship between military spending and GDP, as the military may be able to insulate themselves from short to medium-term fluctuations in the economy.

In the last chapter we argued that high levels of international debt severely restrict government spending, and in particular the ability to finance large capital imports, such as major weapons systems. This effect may be proxied either by levels of debt, or by debt service requirements. The former would probably relate more to external financing capabilities, while the latter to pressures on the government budget. As the two variables are highly correlated, separate models will be estimated for each country using debt levels and debt service as the relevant variable. In each case, the current and lagged values will be included[126].

We also suggested in the previous chapter that inflation could impact military spending levels. For each country we will include both the change and the lagged level of inflation as regressors. The latter may relate to government economic policy considerations, whereby public expenditure may be restricted to tackle high inflation. The former relates more to administrative lag, whereby accelerating inflation may lead to public sector salaries failing to keep pace.

The arguments of the previous chapter suggested that the political dimension of military spending was likely to be important, but that the relationship between political transition

[126] The definition of debt used is for Public and Publicly Guaranteed Debt, defined as "long term external obligations of public debtors, including the national government and political subdivisions (or an agency of either) and autonomous public bodies, and external obligations of private debtors that are guaranteed for repayment by a public entity", see World Bank website. The definition of debt service is Total Debt Service, defined as "the sum of principal repayments and interest actually paid in foreign currency, goods, or services on long-term debt, interest paid on short-term debt, and repayments (repurchases and charges) to the IMF. Both of these come from the World Bank World Development Indicatrs, published annually by the World Bank Group, Washington D.C.

and military expenditure was much more complex than cross-country results, including those of chapters 3-4, would suggest. It would be difficult to construct proxies for all of the considerations discussed: for example the level of institutional power of the military after a transition to democracy, the level of threat of military intervention, the strategy of the civilian government towards the military. We shall continue to use the Polity 98 data on democracy for the three countries used in the previous studies, but in those cases where this does not lead to a significant result, we shall try as an alternative separate dummies for different non-military administrations. In particular we have seen that the Alfonsin and Menem administrations in Argentina took quite different approaches to the military, while the Peronist administration of the 1970s faced very different circumstances again. In Brazil also, the Sarney administration immediately following military rule can be seen as following a pro-military line, in comparison with its successors.

Finally we must consider the dynamics of the military expenditure process For each country we include lagged military spending, as military spending may not adjust immediately to changed circumstances, but is likely to be subject to bureaucratic inertia, commitment to existing programmes, etc. We also include a time trend; this could be seen to represent a powerful military establishment's ability to extract a growing level of funding, aside from the performance of the economy and the threat faced.

All the economic and military expenditure variables are in logs. While in chapters 3-4 we used military burden as the dependant variable, as this is the best way of comparing military expenditure across countries, here we will use the absolute level of military spending, so as not to make any *a priori* assumptions about the nature of the relationship between military expenditure and national income.

We will therefore be estimating models of the form:

$$M_t = \alpha_0 + \alpha_1 t + \alpha_2 M_{t-1} + \alpha_3 Y_t + \alpha_4 Y_{t-1} + \alpha_5 Debt_t + \alpha_6 Debt_{t-1} + \alpha_7 \Delta P_{t-1} + \alpha_8 \Delta^2 P_t + \alpha_9 M'_t + \alpha_{10} M'_{t-1} + \alpha_{11} DEM + \alpha_{12} \text{ (other relevant proxies and dummies)}$$

Where M is military spending, Y is GDP, P is the price level, M' is a relevant neighbour's military spending, and DEM is democracy. Debt may be replaced with debt service, and the democracy variable may be replaced with regime dummies. This therefore represents an ARDL(1,1) dynamic specification with respect to each of the dynamic variables used as regressors. We adopt a general-to-specific approach to estimation, starting with all variables in the equation including the lags and differences specified above, then seek to remove insignificant variables to obtain a parsimonious model. It would also be possible to use a co-integrating approach, but the general to specific approach allows the dynamics of the process – which are not *a priori* obvious – to emerge from the data. However the implicit long-run relationships will be tested for stationarity to ensure that we do not have a spurious regression.

Data for all economic variables comes from the World Bank World Development Indicators 2001. The series described in the previous chapter are used for military spending, and Polity 98 data is used for democracy.

6.2 Model and empirical results for Argentina

Argentina has seen numerous economic and political changes over the thirty year period, as well as major changes and events in the country's security environment, most notably the South Atlantic war with the UK in 1982. All of these factors are potentially important influences on Argentine military spending.

Argentine military spending was fairly steady up to 1974, then began to rise sharply from 1975 (the year before the last military coup) till 1979. Up to 1983 it fluctuated up and down around a steady level, then fell sharply to 1990. Since then, it has stabilised and has in fact risen slightly.

Looked at as a proportion of GDP, the picture is not too dissimilar, except that the decline in military burden continued more or less throughout the 1990's, as GDP rose at an average of 4% a year, but military spending only increased very slightly.

The model for Argentina is based on the generic model above. The main security factors are Chilean military expenditures, dummies for the Falklands/Malvinas war (1982, the year of the war, and 1983, when Argentina spent heavily on arms to replace equipment lost in the war), and a constructed variable ACCON, measuring the degree of political conflict between Argentina and Chile. This ranges from 0 to 3, peaking at 3 in 1978, when the two countries almost went to war, falling to 2 in 1979 when international mediation was agreed, to 1 in 1984 after the Declaration of Peace and Friendship, and finally to 0 after 1994, when the last remaining border dispute was (more or less) definitively settled.[127]

Thus Chilean military expenditures and the ACCON proxy represent alternative ways of looking at the Argentina-Chile rivalry from Argentina's point of view; one suggests that Argentina will follow Chile's level of military expenditure in an action-reaction fashion, akin to a Richardsonian arms race; the other suggests that the progress of the dispute and the associated level of tension would be more significant in determining Argentina's military spending, akin to Oren's (1994) approach for India and Pakistan.

[127] This was based on the HIIK Kosimo database of violent and non-violent conflict classification of the various stages of the Argentina-Chile disputes; "latent conflict" corresponds to a score of 1 for ACCON, "non-violent crisis" to 2, and "violent crisis" to 3. The values are listed in Appendix 4.

Peruvian and Brazilian military expenditures are not included in the initial regressions, as this would give rather too many parameters, and as they are less significant relationships for Argentina than the Chile dispute. However they will be considered as possible additional variables to be added to a reduced model. As Brazil is traditionally a rival of Argentina, we may expect a positive coefficient if any on Brazilian military spending. Peru is to some extent an Argentine ally, at least in terms of having a common enemy in Chile, so the *a priori* sign of Peruvian military spending is indeterminate.

For political factors, initially a democracy variable based on the Polity 98 data was used, as in chapter 4, with mixed results; however, this has two problems: firstly, this shows Argentina as a democracy in, for example, 1983, as there were free elections that year; however the democratic President Raoul Alfonsin only took office in December of that year, and so could not have affected military spending. Secondly, it ignores the different states of military-civil relations that applied at different periods of civilian rule, and possible different approaches by different regimes, as discussed in previous sections. Not surprisingly therefore, this failed to produce a significant result in any of the regressions. Therefore, as an alternative, three separate dummies were used for the three separate democratic administrations during the period: the brief Peronist period from 1973-76 (Campora, then Juan Peron, then Isobel Peron), the Alfonsin administration from 1983-1989, and the Menem administration from 1990-2000, with these set to 1 only in years when the regime in question ruled for a substantial part of the year. (Thus 1973, 1976 and 1983 are all counted as military rule.[128]) We may expect negative coefficients on the democratic regime dummies.

[128] As an alternative, the Peron dummy was set to 0.5 in 1973 and 1976, due to the mid-year regime changes. This did not affect the results.

These three administrations faced different political circumstances, and/or pursued different policies towards the military. The Peronist governments of the 1970s faced constant political instability and the ever-present threat of renewed military intervention, a threat not seriously present after 1983. Post 1983, Menem followed a much more conciliatory policy towards the military than Alfonsin with regard to human rights prosecutions, though not necessarily in financial terms, as the last chapter noted. Thus it is possible that we will find different effects of these three different administrations.

We start with the following variables in the regression for Argentina military spending[129]

Constant, trend, lagged military spending

GDP and lag

Debt and lag OR

Debt service and lag

Chilean military spending and lag

Regime dummies: MENEM, ALFONSIN, PERON[130]

ACCON Conflict with Chile proxy

Dummies for Falklands and subsequent rearmament (1982, 1983)

Table 1 below presents the results of a general-to-specific approach to the estimation from 1971-1999[131]. There are three models, with the second two coming from deleting insignificant variables from the previous one. Table 2 presents summary statistics for these models.

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[129] For all three countries, population was also included in earlier models, as this had proved significant across countries and in the panel data models, but was not included in the final models as at no stage did it prove significant in any of the three. As an additional check, population was added to the final parsimonious models in various specifications, but again proved insignificant for all three countries.
[130] The values of the regime dummies are listed in Appendix 4.
[131] Not all variables were available for 2000

Clearly there are far too many parameters in the first model. As a first step, the irrelevant dummy and constructed variables are deleted: ALFONSIN, PERON, ACCON and the 1982 dummy. An F-test shows these to be jointly insignificant. This gives the second model, where it becomes clearer which variables are significant. The remaining insignificant variables (trend, GDP, Debt, Lagged inflation and Chilean military spending) are jointly insignificant and may be deleted. This gives the third, parsimonious model, which now runs from 1971 to 2000[132]. The r-bar-squared of the final model is 0.978, and the standard error is .0552, which represents a fairly good fit. The Durbin h-statistic shows no problem of serial correlation.

Tests for higher-order serial correlation, functional mis-specification (Ramsey's Reset Test), non-normality of residuals and heteroskedasticity in the third model all proved clearly insignificant.

The results show more or less what one would expect: a positive relation with GDP, but rising debt driving military expenditure down, and rapidly rising inflation leading to military spending failing to adjust and thus falling in real terms. The positive coefficient on lagged Chilean military spending suggest that this has been enough of a threat to prompt Argentine response, and suggests a possible arms race. However, the index of conflict was not significant. (using lagged ACCON instead made no difference.) The significance of the 1983 dummy is probably down to the post-Falklands war re-armament.

[132] As those variables not available in 2000 appear now only in lagged form.

Table 1 Regression results for Argentina (debt model).

Dependant variable is log military spending. 29 observations used, from 1971-1999. Model 3: 30 observations, from 1971-2000.

	Model 1		Model 2		Model 3	
Variable	Coefficient	t-ratio	Coefficient	t-ratio	Coefficient	t-ratio
Constant	3.68	0.54	-0.15	-0.04	***-5.38	-3.73
Trend	0.03	1.09	0.01	1.02		
Military spending$_{t-1}$	***0.68	2.78	***0.58	4.30	***0.51	7.08
GDP	-0.45	-0.96	-0.32	-0.96		
GDP$_{t-1}$	0.64	1.64	**0.76	2.60	***0.85	6.61
DEBT	0.13	0.54	0.07	0.46		
Debt$_{t-1}$	**-0.50	-2.35	***-0.47	-3.44	***-0.33	-8.03
Inflation$_{t-1}$	-0.05	-1.00	-0.04	-1.07		
Δinflation	**-0.11	-2.29	***-0.09	-3.02	***-0.06	-3.42
Chilean military spending	-0.20	-0.82	-0.06	-0.74		
Chilean military spending$_{t-1}$	**0.24	2.62	***0.27	3.71	***0.22	4.21
MENEM	**-0.49	-2.62	***-0.39	-5.43	***-0.38	-6.19
ALFONSIN	-0.06	-0.48				
PERON	0.10	0.59				
ACCON	0.03	0.45				
1982 dummy	-0.03	-0.36				
1983 dummy	**0.25	2.38	***0.30	4.67	***0.29	4.77

* = significant at the 10% level ** = 5% level *** = 1% level

Table 2: summary statistics for Argentina debt model.

Model no.:	1	2	3
Adjusted R^2	.977	.980	.978
Standard Error	.06	.052	.055
Durbin h	N/A	-1.58 (p=.114)	-.09 (p=.928)

The regime dummies at first sight give a slightly surprising result, in that while the Menem administration show significantly lower military spending, the Alfonsin dummy is insignificant, even though it was under Alfonsin's government that military spending fell by most. A closer analysis provides the explanation: under Alfonsin, GDP actually shrank (see previous chapter), while under Menem it rose at a rate of around 4% a year. Also, Alfonsin faced the first heat of the debt crisis. Thus for his administration, cuts in military and other public expenditures were a harsh economic necessity (though whether things would have been the same under continued military rule is moot). Alfonsin chose to take on the military in other domains, such as human rights prosecutions, as discussed in the last chapter. Menem kept military spending more or less constant despite strong economic growth, and thus greatly reduced the military burden. He was, on the other hand, more conciliatory towards the military in other spheres, for example pardoning the former military rulers jailed for human rights abuses. (Of course it is far easier to not increase military spending in conditions of growth than to actually cut it, regardless of the circumstances.) Perhaps the picture is best summed up by Fitch:

"Although the military's budget problems have worsened, Menem seldom misses an opportunity to socialise with the military or to praise their patriotism and professionalism. The contrast with Alfonsin in symbolic terms could scarcely be greater. As a result, Menem gets generally favourable or mixed ratings for his treatment of the military, despite the lack of budgetary payoffs, compared to the overwhelmingly negative evaluation of Alfonsin's military policies." (Fitch, 2000, p.79)

As discussed above, we consider Brazilian and Peruvian military spending as possible additional variables, in each case using an F-test to add the current and lagged value of each country's military spending to model 3. Brazilian military spending is completely insignificant, but lagged Peruvian military spending has a significant positive coefficient, but including this variable does not greatly change the other coefficients, though the significance level of the change in inflation variable falls to the 5% level.[133]

We now move on to the model using debt service. These results, shown in table 3 below, were much less satisfactory. Although the R^2 of 0.98 is quite good, some of the variables seem to have the 'wrong' sign, in particular the negative coefficient on the 1982 Falklands war dummy, with the 1983 rearmament dummy insignificant. Furthermore, there is considerable ambiguity as to which variables should be left in the model; in several cases, groups of variables turn out to be jointly significant, though individually insignificant. Unlike the debt model, where there was a fairly natural choice of variables to delete at each stage, in this model the final parsimonious version was highly contingent on some fairly arbitrary choices of order of deletion of variables. Both in the initial full model, and in any choice of reduced model, the debt version had a higher adjusted R^2 and log likelihood, and lower standard error, and was preferred to the debt service version by a number of non-nested tests, including Cox's J-test. When comparing reduced models, it was also possible to compare the models by including all the variables that were significant in either; whichever reduced-form debt service model was used, the result was

[133] This positive coefficient of Peruvian military spending is somewhat hard to explain; if it were simply a matter of keeping up with regional trends one would expect a stronger effect from Brazilian military spending. It is possible that, as both Argentina and Peru have Chile as a rival, they are both responding to perceptions of Chilean intentions not adequately picked up by Chilean military spending, or by the ACCON variable. Alternatively, they may both be responding to regional or global trends. At any rate, this study has not been able to find any suitable proxy to explain the relationship, which may simply be coincidental.

that those variables only in the debt model were still significant, while those variables unique to the debt service model became insignificant. By every possible measure therefore, the debt model is to be preferred.

Table 3: Debt service model for Argentina

Dependant variable I log military spending. 29 observations used, from 1971 to 1999.

	Model 4	
Variable	Coefficient	t-ratio
Constant	-1.04	-0.1
Trend	0.031	1.0
Military spending$_{t-1}$	**0.93	3.0
GDP	-0.70	-1.1
GDP$_{t-1}$	*1.10	1.80
Debt Service	**-0.27	-2.5
Debt Service$_{t-1}$	0.16	1.6
Inflation$_{t-1}$	-0.083	-1.2
Δinflation	**-0.16	-2.6
Chilean military spending	-0.30	-1.4
Chilean military spending$_{t-1}$	0.10	0.79
MENEM	**-0.51	-2.2
ALFONSIN	-0.18	-1.4
PERON	0.27	1.3
ACCON	0.089	1.1
1982 dummy	*-0.23	-2.0
1983 dummy	0.17	1.3
Adjusted R^2	0.962	
Standard Error	0.074	

Testing the long-run relationship

From the results of model 3 in table 2, we can derive a long-run relationship of

M = -10.98 + 1.73*GDP - 0.67*Debt +0.45*Chilean milex

(with all variables in logs). We therefore test the long-run vector ALR = M+10.98-1.73*GDP+0.67*Debt-0.45*Chilean milex for stationarity, using a Dickey-Fuller (DF) or Augmented Dickey-Fuller (ADF) test: the change in the long-run vector, ΔALR, is regressed on a constant, ALR_{t-1}, and one or more lags of ΔALR (zero for the DF test). If the coefficient of ALR_{t-1} is insignificant, we cannot reject the null hypothesis that ALR is in fact non-stationary, as the change in ALR is independent of is lagged level. If ALR_{t-1} is significant and negative, this indicates that ALR is stationary - any divergence from the long-run relationship will tend to die out, as ALR has a tendency to fall back towards zero. In the Dickey-Fuller regressions, the t-ratio of ALR_{t-1} does not have the usual distribution; critical values specific to the ADF regression must be used. These are supplied by the Microfit estimation package with which these regressions were carried out. As a linear trend was not significant for Argentina, we use the ADF tests without a linear trend. Model selection criteria indicated using at most the ADF test of order 1; however both the Dickey-Fuller (DF) and ADF(1) tests found the coefficient of ALR_{t-1} to be insignificant, indicating that the long-run relationship is non-stationary, in other words, not actually a long-run relationship. This seems problematical; however, there is a problem with the long-run vector as stated, in that it excludes the MENEM regime dummy. While this is properly treated as a short-run variable, the fact that it is set to one for around a third of the estimation period means that leaving it out would distort the results; as MENEM has a negative coefficient, the long-run vector would tend to be lower during the 1990s when it is set to one, creating an apparent serial correlation. To correct for this, an ADF(1) regression was carried out with MENEM as an additional right-hand side variable; this time, the t-ratio for ALR_{t-1} was equal to –3.6524, well above the 95% critical value for the test. This remained the case when ΔALR_{t-1}, which was insignificant, was removed, giving a DF regression. We may thus reject the null hypothesis of non-stationarity, and conclude that the long-run relationship for Argentina is indeed stationary, and that we do not have a spurious regression.

We see from the above that the long-run coefficient of GDP on military spending, 1.73, is considerably greater than one, making military spending a 'luxury' good for Argentina. The hypothesis that the long-run coefficient is in fact equal to unity can be tested by putting the change in military spending on the left hand side of the equation, and then using an F-test to compare the model with both lagged GDP and military spending against the model using only ($\log Milex_{t-1} - \log GDP_{t-1}$).[134] The result gives $F(1,22)=5.65$, which is significant at the 5% level, leading us to reject the null hypothesis, and conclude that the long-run coefficient is greater than 1. (The unrestricted model has an R-bar squared of 0.80, a fairly satisfactory outcome.) However, when lagged Peruvian military spending is included in the equation, the coefficients of lagged military spending and lagged GDP on military spending go down to 0.44 and 0.76 respectively, leading to a long-run coefficient of 0.76/(1-0.44)=1.36. This time, $F(1,21)=1.42$ leads to acceptance of the null hypothesis of a unitary long-run coefficient.

The choice of an ARDL(1,1) dynamic specification seems to have been justified by the results. A comparison can be made with other dynamic specifications using the log likelihood function. We use the debt model, and compare maximised log likelihood for a

[134] This is not the same as the military burden, the share of military spending in GDP, as military spending has been calculated in accordance with SIPRI conventions using the CPI to deflate nominal figures, while GDP has been deflated using the GDP deflator.

number of dynamic specifications, deleting only the insignificant dummy and constructed variables. The results are as shown below in Table 4:

Table 4: Log likelihood for different dynamic specifications for Argentina.

Model	Log Likelihood
ARDL(1,1)	53.0
DL(1)	45.4
AR(1)	41.2
Static	31.5
1st difference	27.5

From these figures, it is clear that the ARDL(1,1) model is far superior to the restricted models. However there is some evidence that it is not sufficient to capture the full dynamics of the process. On the one hand, the second lag of military spending is not significant when added to the parsimonious model with debt. However, the second lags of GDP, debt and Chilean military spending, and the lagged change in inflation are jointly significant at the 5% level according to the likelihood ratio test, though insignificant according to the F-test. In fact, it is just the 2nd lag of GDP and the lagged difference in inflation which are individually significant at the 5% and 10% levels respectively, and these two on their own are jointly significant at the 5% level according to the LR test, and the 10% level according to the F-test. Adding these two variables to the model renders the first lag of GDP insignificant. If this is deleted to produce a new parsimonious model, the result is a slight increase in the R-bar squared and the likelihood function, and a slight reduction in the standard error. On the other hand we have lost two degrees of freedom (one more variables and one less observation), and have significantly increased the dynamic complexity of the model.

Overall, the results suggest a fairly typical pattern, with military expenditure strongly affected by economic circumstances (GDP, debt and inflation), but also by rivalry with Chile, and by the Falklands war. The effect of the transition to democracy does not show up as strongly as the figures initially suggest, and it is, again at first sight somewhat surprisingly, the Menem administration that seems to have kept military spending most in check, under the circumstances of a growing economy.

6.3: Model and empirical results for Brazil

Brazilian military spending fell gradually from 1971 to 1981, then started to rise again gradually, through and beyond the transition to democracy. An exception is in 1990 and 1991 where the figures show a drastic drop – following an almost equally huge rise in 1988. These figures must be treated with some suspicion, falling as they do in years of hyperinflation, when accurate measurement of expenditure data becomes quite troublesome.

The Brazilian model is again based on the generic model. Brazil has had no wars or major security events during the period in question (or indeed since WW2), so security factors do not figure prominently. However, Argentina was for a long time Brazil's only serious rival for regional hegemony, though the two moved towards economic and military co-operation through the 1980s and 90s. Nonetheless, to include Argentine military spending seems reasonable.

Dummy variables are included in the regression for 1988, 1989, 1990 and 1991, the years when the data is most suspect, though this has the unfortunate effect of reducing the degrees of freedom.[135]

Democracy was also included as a political factor, but as the results below show, this was insignificant. An alternative model used separate dummies for the four post-transition presidencies: Sarney, Collor, Franco and Cardoso. As this involves rather a lot of dummy variables, another model was tried which merely distinguished Sarney's presidency from those after him, on the grounds that Sarney was seen as much more supportive of the military; he was also much more reliant on their support, as he had not been directly elected and so had only questionable democratic legitimacy. As neither of these alternative sets of variables proved significant, the models shown are the one using the single Democracy variable.

We start with the model using debt. GDP, debt and Argentina military spending are included both current and lagged, while inflation is included lagged and differenced. In all the following regressions, the sample is from 1972 to 1999, as military spending data for Brazil was not found for either 1970 or 2000.

The results are shown in table 5 below. Model 1, the full model, does not provide very encouraging results, with few variables other than the year dummies significant at even the 10% level. Clearly the model is over-parameterised. The 1990 and the democracy variable are individually and jointly insignificant, so may easily be deleted. Furthermore the only

[135] If the assumption is that 'spikes' in these years represent data errors rather than unusual circumstances, this also introduces bias, in that the figure for the lagged dependent variable is incorrect the year after the supposed 'error'. This can be corrected for as follows: first run a regression including an extra dummy variable for the year after the last 'error' year. This gives consistent estimates of the parameters, in particular the coefficients of the dummy variables for the error years. These coefficients can therefore be used to adjust the data for these years, giving consistent estimates of the true values. Using this revised data, a second regression is run without the extra dummy variable. This now produces consistent estimates. When this was

external variable used, Argentine military spending, also seems to be insignificant, and these two variables are also jointly insignificant on their own and alongside the 1990 dummy and the democracy variable. Removing these gives model 2, which describes Brazil's military spending in terms of only economic factors.

carried out for the models described below, the only difference was that the lagged dependent variable became insignificant. Removing this variable reduced the adjusted R^2 to around 0.9.

Table 5: Regressions for Brazil (debt model)

Dependant variable is log military spending. 28 observations used, from 1972-1999.

	Model 1		Model 2		Model 3	
Regressor	Coefficient	T-Ratio	Coefficient	T-Ratio	Coefficient	T-Ratio
Constant	11.47	1.41	4.78	0.88	***5.34	5.43
Trend	*0.08	1.92	***0.05	4.09	***0.05	6.97
$Milex_{t-1}$	0.09	0.40	**0.24	2.46	**0.23	2.43
GDP	0.76	0.81	0.69	1.13		
GDP_{t-1}	-1.53	-1.25	-0.79	-1.28		
Debt	0.60	1.06	0.34	0.84		
$Debt_{t-1}$	*-0.86	-1.83	*-0.60	-1.97	***-0.42	-4.96
$Inflation_{t-1}$	-0.05	-1.22	-0.03	-0.90	*-0.05	-1.89
ΔInflation	**-0.13	-2.55	***-0.11	-3.16	***-0.12	-3.78
Arg. Milex	0.33	0.72				
Arg. $Milex_{t-1}$	-0.12	-0.35				
Democracy	0.01	0.95				
1988	***0.59	3.17	***0.56	4.99	***0.52	5.29
1989	*0.57	2.06	***0.43	3.49	***0.41	3.75
1990	0.27	0.72				
1991	***-0.64	-3.63	***-0.72	-6.21	***-0.76	-6.90
Adjusted R^2	.933		.944		.946	
Standard Error	.100		.091		.090	
Durbin h-statistic	N/A		-.321 (p=.75)		-.473 (p=.636)	

This is beginning to give a clearer picture, but a surprising feature is the insignificance, (individually and jointly) of the GDP variables, while there is an upward deterministic trend. As the coefficients on the current and lagged value of GDP above are close to equal and opposite, one approach is to use the first difference. However this is still insignificant, and this does not greatly change the other coefficients.

Nonetheless model 2 shows some features in keeping with what might be expected. We see an upwardly trended ARDL(1,1) process, with debt and inflation having a negative impact on military expenditure. There is a positive effect of change in GDP, but this is not significant. In seeking a parsimonious representation, we attempt to delete the GDP variable(s), current debt, and lagged inflation. The null hypothesis of their joint insignificance is rejected at the 10% level by the likelihood ratio test (or at the 5% level starting from the model with GDP differenced). If we choose to leave lagged inflation in, the other variables are jointly insignificant, finally giving model 3 as a parsimonious representation.

The R-bar squared for model 3 is 0.946, giving a poorer fit than for Argentina. There is a possible problem of functional form, with Ramsey's RESET test using the square of the fitted values showing a significant result at the 5% level.

The debt service model produces remarkably similar results. This time we only present the final, parsimonious model in Table 6 below. In the general model, we again find that the 1990 dummy and the democracy variable are jointly insignificant and can clearly be deleted. A joint variable deletion test on the Argentine military spending, GDP and debt service variables shows them to be jointly significant, suggesting some sort of multicollinearity. A first stage is to test the hypothesis that only internal factors are relevant by testing the joint significance of the Argentine military spending variables. These are jointly insignificant. When deleted, the multicollinearity problem between debt service and GDP remains. However, while the GDP variables are jointly insignificant, the debt service variables are jointly significant, and lagged debt service becomes individually significant once GDP is removed from the equation.

Table 6: Debt service model for Brazil

Dependant variable is log military spending. 28 observations used, from 1972-1999.

Regressor	Coefficient	T-ratio
Constant	***2.67	6.3
Trend	***0.038	7.8
Military spending$_{t-1}$	***0.34	4.3
Debt service$_{t-1}$	***-0.22	-5.3
Inflation$_{t-1}$	***-0.085	-3.2
ΔInflation	***-0.15	-4.6
1988	***0.45	4.8
1989	***0.44	4.1
1991	***-0.83	-7.8
Adjusted R^2	.950	
Standard Error	.086	
Durbin h-statistic	-.803 (p=.422)	

This time there is no problem with the Ramsey's RESET test, and tests for higher order serial correlation, heteroskedasticity and non-normality of residuals also give insignificant results.

This model is almost identical to the preceding one, though with a slightly higher R-bar squared and likelihood function and a slightly lower standard error. Together with the issue of functional form, this suggests this model is marginally to be preferred, though it makes very little difference. The most striking features about these models (model 3 with debt, and the debt service model) are that (1) it exhibits Brazilian military spending as a function of purely internal, economic factors, with external and regime factors irrelevant; and (2) that national income as measured by GDP appears to be insignificant, with military spending instead displaying a strong upward trend regardless of fluctuations in income.

The first conclusion is not greatly surprising. As has been noted, Brazil has not been involved in a war with any of its neighbours since the 19th century and, while viewing Argentina as a rival for regional pre-eminence, has not had a serious dispute with them in recent times. As was noted in the last chapter, Brazil rarely furthered their regional ambitions in a manner antagonistic to neighbouring powers.

As for the insignificance of the regime change, this is not surprising given the discussion of the previous chapter: the military retained significant residual power and a measure of popular support, enabling them to demand and obtain reasonably generous budgetary settlements. Also the civilian governments after President Sarney seemed to be inclined to buy the military's acceptance of subordination to the civil power with increased budgets and an enhanced role (see previous chapter, section 6).

The second result is rather more striking. One possible interpretation is that it supports an institutionalist understanding of military expenditure as opposed to a utility maximising model. In the latter case, we would certainly expect a positive relationship with GDP, as welfare maximisation presupposes some rational allocation of the nation's resources as measured by GDP. An institutionalist approach could allow for military spending simply to rise over time by a 'ratchet effect' whereby expenditure generates new programmes with an accompanying bureaucracy and interest group, which must then be maintained. It is also possible to interpret this in terms of the military's rent-levying capabilities, which did not end with the advent of civilian rule (see previous chapter): with a general expectation of rising national income, and a low base for the military share of GDP, the military is able to extract an increasing quantity of resources from society, but without a clear long-run relationship with income.[136]

The other economic factors have the expected effect, with rising debt restricting military spending (and very likely other public spending). Both the change in inflation and the lagged level have a clearly negative effect. As discussed, the first can be understood in terms of the failure of military salaries to keep pace with accelerating inflation, while the second could be a policy response of public sector budget cuts in response to high inflation.

As with Argentina, we test the long-run relationship for stationarity. From Table 6, this is:

$$M = 4.05 - 0.33*\text{Debt service} - 0.13*\text{Inflation},$$

again with the variables in logs. The long-run vector is therefore BLR=M-4.05+0.33*Debt service+0.13*Inflation. As a linear trend was highly significant for Brazil, we must use the Dickey-Fuller regressions including a linear trend. Model selection criteria indicate an ADF(1) test, and the t-ratio for BLR_{t-1} is –4.4136, well above the 95% critical value for the ADF test with linear trend. We may conclude that the long-run relationship is stationary.

[136] One alternative approach is to *a priori* omit a trend. The results are rather unsatisfactory: Although a significant coefficient for lagged GDP is obtained, debt becomes insignificant, and there is a negative coefficient on Argentine military spending. The R-bar squared is much lower, and non-nested tests clearly prefer the specification with a trend: if the fitted values from both models are retained, then the fitted values from the trended model is highly significant when added to the model with GDP but no trend, while the

Considering alternative dynamic models, again the ARDL(1,1) model seems justified, but this time the static model (with trend), and other intermediate nested models give reasonable results. The maximised values of the likelihood function (in the debt service model, with the democracy variable and 1990 dummy removed but other variables left in) are as follows:

Model	Maximised LL
ARDL(1,1)	35.0
AR(1)	29.6
DL(1)	28.0
Static	25.3
1st Difference	11.9

However in this case there is quite strong evidence that a second lag at any rate of inflation need be considered, as this variable is highly significant when added to either model. The revised model for debt service, with the inflation dynamics expressed in terms of current and lagged difference, and the second lag of the level, is shown in Table 7.

fitted values from the latter model are clearly insignificant when added to the trended model. The trended model is thus statistically much more robust than one without a trend.

Table 7: ARDL (1,2) model for Brazil

Dependant variable is log military spending. 28 observations used, from 1972-1999.

Regressor	Coefficient	T-Ratio
Constant	***3.14	7.7
Trend	***0.05	9.0
$Milex_{t-1}$	***0.28	3.8
Debt $Service_{t-1}$	***-0.27	-6.6
ΔInflation	***-0.17	-5.8
$\Delta Inflation_{t-1}$	*-0.05	-2.0
$Inflation_{t-2}$	***-0.13	-4.5
1988	***0.44	5.4
1989	***0.44	4.7
1991	***-0.87	-9.2

This gives a considerable improvement in the value of R-bar squared, which is now 0.962, while the standard error has fallen to .0751. The log-likelihood has gone up from 34.3 to 38.9. Broadly speaking however, the picture that emerges is the same as before.

Overall, the results are much less satisfactory than for Argentina and Chile (below), especially in terms of the number of dummy variables, but this is inevitable given the poorer quality of the data.

6.4 Model and empirical results for Chile

In Chile, military burden rose dramatically but erratically through the 70's and early 80's, though there are noticeable peaks in 1974 and 1978, times of high tension with Peru and

Argentina respectively. Thereafter the military burden declined steadily, though it levelled out in the late 90's. The fall clearly predates the restoration of democracy in 1989. In terms of the level of military spending, this represents a rapid rise through the early period, and a more gradual rise thereafter.

We again use the generic model described above. Argentine military spending, Peruvian military spending, and the ACCON proxy for the level of tension with Argentina are used as security variables. The Polity 98 Democracy variable is used as a political factor. A dummy for 1974 is included, a year which saw a large spike in Chilean military spending. If not purely the result of a data glitch, this spike could relate to two factors: high tension with Peru, which led some neighbouring countries (especially Bolivia) to believe that war was imminent[137] and the first year of the Pinochet regime, a year of massive repression. Thus it is not possible to tell if this represents an 'external' or an 'internal' factor, or a combination of the two.

We again consider alternate models using debt and debt service. The results for the debt model are given in table 8 below. (The sample runs from 1971 to 1999). As before we look to remove irrelevant dummy and constructed variables from the full model; in this case, only ACCON was insignificant, with the 1974 dummy significant and positive, and the democracy variable significant and negative. Model 1 in Table 8 shows the results once ACCON was removed.

There are severe problems with model 1, with the Durbin h-statistic indicating significant negative serial correlation, which renders our estimators biased and inconsistent, and Ramsey's RESET test suggesting a functional mis-specification. However this may be due to the large number of irrelevant variables included.

[137] Guardian 11/11/1974

The insignificant variables in model 1 are also all jointly insignificant, and may be removed to give model 2, a parsimonious model, which no longer has the serial correlation and functional form problems of model 1.

As in the case of Brazil, we appear to see an upward trend that is independent of the trajectory of national income, possibly supporting an institutionalist rent-exacting hypothesis. Military spending is clearly influenced by inflation and, slightly more weakly, by debt. If an upward trend regardless of income is indeed a sign of military influence and autonomy, then it is consistent that this effect should appear for Brazil and Chile, where the military retained both after handing over to a civilian regime, but not for Argentina. Interestingly, the external factors of Argentine and Peruvian military spending (as well as the tension dummy ACCON), seem to be irrelevant.

It may be initially somewhat surprising that we have such a clear negative influence of democracy in Chile, where the military retained so much power and influence. This must be related to the precise conditions of civil-military relations is Chile, discussed in the previous chapter. Pinochet's constitution guaranteed that military spending would not fall beneath the 1989 level, and also gave the military 10% of the sales of Coldeco for arms purchases. Essentially the military seem to have been satisfied with this, though Pinochet may have believed that his civilian successors would be less successful economically than they were. At any rate as noted in Chapter 5, analysis of Latin American Weekly Reports and other sources show very few occasions of military complaints over the budget, nor of civilian attempts to reduce it (though transparency of military spending was an issue). On the other hand, the military defended their institutional privileges tooth and nail, and in particular sought to oppose human rights trials. Thus the budget has not been a major bone of contention between the military and civil powers and so, as the economy grew, military spending has been allowed to fall as a share of GDP without attracting Pinochet's ire. (Though more than likely he would have sought to give the military a larger slice of the prosperity had he been in power.) As it was, other issues were paramount.

The dummy for 1974 is highly significant and positive, though whether this relates to the severe repression of the first full Pinochet year, to tensions with Peru, or simply a measurement error, it is not possible to say.

Most of the coefficients have not changed very much from the previous model. However the removal of the irrelevant variables has greatly reduced the standard errors of the coefficients and thus increased the t-ratios, as one would expect. The Durbin h-statistic is now insignificant.

Table 8: Debt model for Chile

Dependant variable is log military spending. 29 observations used, from 1971-1999.

	Model 1		Model 2	
Regressor	Coefficient	T-ratio	Coefficient	T-ratio
Constant	***12.7	4.1	***10.3	7.4
Trend	**0.051	2.7	***.033	5.0
$Milex_{t-1}$	***0.50	3.0	***.51	6.0
GDP	-0.36	-0.6		
GDP_{t-1}	0.37	0.9		
Debt	-0.043	-0.1		
$Debt_{t-1}$	**-0.58	-2.3	***-.41	-3.7
$Inflation_{t-1}$	***-0.31	-3.1	***-.32	-6.8
ΔInflation	***-0.39	-3.6	***-.38	-6.2
Argentine Milex	-0.23	-1.0		
Argentine $Milex_{t-1}$	0.15	0.9		
Peru Milex	0.084	0.7		
Peru $Milex_{t-1}$	0.12	1.0		
Democracy	**-0.025	-2.2	***-.028	-5.5
1974 dummy	***0.84	5.8	***.86	9.4
Adjusted R^2	.964		.969	
Standard Error	.073		.067	
Durbin h-statistic	-3.11 (p=.002)		-1.14 (p=.256)	

The alternative model uses debt service instead of debt. This time the sample runs from 1972 to 1999, as debt service figures for 1970 were not available. The results are shown in

Table 9 below. Model 3 gives the full model, while model 4 gives the parsimonious model. Again in model 3 the Durbin h-statistic shows negative serial correlation and Ramsey's RESET test shows a problem of functional form.

Table 9: Debt Service models for Chile

Dependant variable is log military spending. 29 observations used, from 1971-1999.

	Model 3		Model 4	
Regressor	Coefficient	T-ratio	Coefficient	T-ratio
Constant	***9.2	3.2	8.0	***7.3
Trend	0.015	1.0	0.038	***5.0
$Milex_{t-1}$	**0.33	2.1	0.35	***3.9
GDP	0.45	0.9		
GDP_{t-1}	-0.12	-0.3		
Debt Service	0.037	0.4		
Debt $Service_{t-1}$	0.014	0.1		
$Inflation_{t-1}$	-0.15	-1.2	-0.12	**-2.3
ΔInflation	*-0.33	-2.1	-0.23	***-3.3
Argentine Milex	-0.40	-1.5		
Argentine $Milex_{t-1}$	0.13	0.7		
Peru Milex	-0.039	-0.3		
Peru $Milex_{t-1}$	0.11	0.8		
ACCON	**0.12	2.8	0.13	***3.6
Democracy	*-0.026	-2.1	-0.020	***-4.7
1974 dummy	***0.68	4.8	0.75	***7.9
Adjusted R^2	.955		.968	
Standard Error	.071		.068	
Durbin h-statistic	-2.12 (p=.034)		-.336 (p=.737)	

There may also appear to be a problem of multicollinearity in this model, with only lagged inflation out of the economic variables showing significant, but with a high value of R-squared. It is possible that the GDP variables in particular and the linear trend may be interfering with each other. However the ACCON variable is significant and positive this time, the only indication so far of any influence from relations with neighbours, and again we have a negative effect from democracy, with the 1974 dummy significant and positive.

An F-test strongly rejects the joint deletion of all the insignificant variables above. (Trend, GDP, Argentine & Peruvian military spending, debt service, and lagged inflation.) In particular the trend and the GDP variables are found to be jointly highly significant by a likelihood-ratio test, though not by an F-test. This confirms the suggestion that we have a problem of multicollinearity here.

On the other hand, the neighbours' military spending variables are all jointly insignificant and when these are removed, we find the trend and lagged inflation become significant. GDP and debt service are then also jointly insignificant, and when these are also removed, we obtain model 4, the parsimonious model, which now once again runs from 1971 to 1999, as debt service has been removed.

The adjusted r squared and standard error are almost identical to the model with debt. Again, the Durbin h-statistic is now insignificant, but there remains a problem with the Ramsey RESET test. Comparing the two models, all the same variables are significant and in the same direction, except that ACCON is significant and positive in the model without debt, while the debt model has a significant debt variable, which the second model omits. The coefficients are somewhat different, with those in the model with debt generally having somewhat higher absolute values. Some of the t-ratios in this model are also higher.

This suggests a slight preference for the debt model, but another possibility is to combine the two models by including both ACCON and lagged debt along with the other variables significant in both models. When this is done, lagged debt is barely significant at the 10% level, while ACCON is not quite significant at the 10% level. However an F-test shows them to be jointly highly significant at the 1% level, indicating some multicollinearity between the two, though this is surely coincidental. The r-bar squared and standard error both improve somewhat. It would seem reasonable therefore to keep both variables in the model. This is shown in table 10 below.

Table 10: Combined model for Chile, reduced form.

Dependant variable is log military spending. 29 observations used, from 1971-1999.

Regressor	Coefficient	T-Ratio
Constant	9.7	***6.8
Trend	0.039	***5.4
$Milex_{t-1}$	0.42	***4.4
$Inflation_{t-1}$	-0.22	**-2.9
ΔInflation	-0.30	***-3.8
$Debt_{t-1}$	-0.25	*-1.7
ACCON	0.077	1.6
Democracy	-0.026	***-5.0
1974 dummy	0.80	***8.4
Adjusted R^2	.971	
Standard Error	.065	
Durbin h-statistic	-1.25 (p=.210)	

All diagnostics are satisfactory. We test the long-run relationship for stationarity. The long-run relationship from Table 10 is

$$M = 16.72 - 0.38*\text{Inflation} - 0.43*\text{Debt} + .13*\text{ACCON} - .045*\text{Democracy}.$$

Forming the long-run vector CLR as before and running the Dickey-Fuller regressions with a linear trend, the model –selection criteria appear to suggest an ADF(3) model, which is slightly surprising; however for all orders of the ADF test up to and including ADF(3), the t-ratio of CLR_{t-1} is well in excess of the 95% critical value of the ADF test, so we may once again conclude that the long-run relationship is stationary.

We now consider various alternative models. First of all, as with the other two, we consider alternative dynamic models, on the one hand more restricted specifications, on the other, including second lags of some or all of the variables. Secondly, given that external strategic variables proved at best marginally significant in the initial models, we look at an alternative way of treating neighbours' military spending. Thirdly, as with Brazil, we consider excluding a trend from the equation due to the highly counterintuitive insignificance of GDP when a trend is included.

We thus compare the ARDL(1,1) used above with more restricted models, using the maximised values of the likelihood function. Using the model with debt, the following table lists log likelihood values of different models before removal of insignificant variables:

Model	Maximised LL
ARDL(1,1)	45.9
AR(1)	41.2
DL(1)	40.5
Static	32.45
1st difference	27.5

From this it seems that the AR(1) model (i.e. with lagged military spending but only current values of the other variables) is not too bad, though the lagged variables are still jointly significant by an LR test. This model, like the ARDL specification, shows a negative impact of debt, inflation and democracy, and a positive trend, but no relation with GDP or external variables.

Nonetheless, we see that the full ARDL(1,1) model does have significantly greater explanatory power than any of the nested models. It is therefore worth considering again whether a second lag of any or all of the variables may be significant. The second lag of the dependant variable is not significant, but the second lags of the right-hand side variables (GDP, Debt, Inflation, Argentine & Peruvian military spending) are jointly highly significant according to the LR test, though not the F-test. (Chi-squared(5) for the LR test is 15.5). In particular, the second lags of Argentine military spending and debt are individually significant (+ve, 5% level, -ve, 10% level respectively), and are jointly significant at the 5% level (F-test) or 1% level (LR test.) The other three second lags are not significant.

Adding these variables leaves the 1st lag of debt and ACCON insignificant. Removing these to produce a new, parsimonious ARDL(1,2) model gives an R-bar squared of 0.973 and a standard error of 0.055, slightly better than the previous model. Including the second lags of Argentine military spending and debt does not affect the significance of the current and first lags of these variables, which remain insignificant.

If this ARDL(1,2) model is to be accepted, we now have evidence of an action-reaction effect between the military expenditures of Argentina and Chile, though with asymmetric lag structures. In other words, although we have chosen not to start from a Richardsonian arms-race approach to estimating demand for military spending, the results we have obtained suggest an arms-race type effect as one factor affecting each country's military spending. However it should again be noted that this model has only marginally more explanatory power than the ARDL(1,1) model, and involves an extra layer of dynamic complexity. The question of an Argentina-Chile arms race is investigated further through a co-integrating VAR framework in appendix 5.

The variables for Argentine and Peruvian military spending proved insignificant in the original models, at least when only one lag was employed. One problem with these models has been an excessive number of variables, so an alternative is to use a combined variable equal to the sum of Argentina's and Peru's military spending up to 1984 and just Peru thereafter was tried, to represent a "Potential Enemies" total in keeping with the methodology of chapters 3-4.[138] This also has the advantage of linking rivals' military spending with changing levels of dispute. However this variable was insignificant when added to the parsimonious ARDL(1,1) model, even when ACCON was excluded.

The insignificance of GDP in the equation for military spending is counter-intuitive from a utility-maximising point of view, so as with Brazil, one may consider leaving out the linear trend to try to establish a positive relationship with GDP. Using an ARDL(1,2) model, although there is severe multicollinearity, a meaningful set of results can be produced once the insignificant external variables, namely Argentine & Peruvian military spending and ACCON, are removed. This time debt is also insignificant, but there is a positive relationship with GDP as expected, and a negative relationship with inflation and democracy. However the R-bar squared and log-likelihood functions are much lower than for the trended model, with the same number of regressors overall. Furthermore, Ramsey's RESET test shows a serious problem of mis-specification. Using the fitted values from the two regressions for a non-nested test, the fitted values from the trended model are highly significant (at the 0.1% level of significance) when added to the non-trended model, while the fitted values from the non-trended model are insignificant when added to the trended model. Thus the statistical evidence for the trended model seems to be overwhelming, indicating that an institutionalist understanding of military spending in Chile is more appropriate than one based on rational resource allocation.

Of these alternative specifications therefore, the only one that seems worth considering is adding the second lags of Argentine military spending and debt, removing the first lag of debt and the Argentina-Chile conflict variable.

6.5 Conclusions

This chapter has estimated time-series regressions of the demand for military spending in Argentina, Brazil and Chile, incorporating economic, strategic and political variables following on from the analysis of chapter 5. Though there are some similarities in the results for the three countries, in many ways the differences are more pronounced. Table 11 below summarises the results for the three countries.

[138] Properly speaking, Bolivia should have been included in this total, but as its military spending is small compared to the other two, leaving it out shouldn't affect the result.

There are only two factors that seem common to all three countries, namely the negative impact of inflation, especially accelerating inflation, and debt. In Argentina and Chile, debt levels seem to work best, while in Brazil it is debt service, but both measure the fiscal and external financing constraints facing countries with debt problems.

In contrast, the link between military spending and GDP or lack thereof provides strikingly differing results. Argentina behaves as one would expect from a utility maximising perspective, with a significant positive effect of GDP on military spending. For Brazil and Chile, although there is some GDP effect if a trend is forcibly excluded from the model, in both cases a model showing military spending rising according to a deterministic trend, regardless of national income, works far better in terms of all the relevant econometric measures. This perhaps reflects the continuing ability of the military to insulate themselves from the economic cycle via extra-budgetary sources of income, and general political clout. These results give some support to the hypothesis that military spending in these countries is better understood as including an economic rent for the military's institutional power or influence, and their monopoly of armed force, than as the result of a rational allocation of resources to maximise national welfare.

One would surely expect national income to have some effect in the long run – for example if one of these countries were to experience a sustained recession over a number of years it might prove hard to maintain levels of military spending - but the cyclical and secular fluctuations in growth have not been prolonged enough to have a noticeable impact on an institution with formidable political defences against economic woe. Both countries have had, as one would expect, generally rising levels of income, though with some periods of recession, and in expectation of such a trend, the military have been able to obtain generally increasing resources, other things being equal.

The debt crisis however seems to have posed problems of a different order, which have restricted even the military's spending power – for example it would be difficult to obtain external financing for weapons deals in the face of such debt problems. As has been discussed, accelerating inflation always has a tendency to leave public sector salaries behind – though in the case of the military there will always be a strong political incentive for this to be caught up in subsequent years.

Only Argentina shows an unambiguous impact of external factors, with both the post-Falklands war rearmament and Chilean military spending having a significant positive effect. Chile shows more ambiguous signs of being influenced by the conflict with Argentina, with Argentine military spending only significant if one allows the second lag to be considered, or the variable proxying the level of tension significant only if debt is omitted, as there is a multicollinearity problem. With Brazil, as one might expect for a country that had not been involved in a war with its neighbours for over a century, and had not even been close to war in a very long time, there was no sign of any external link. It would seem that variations in Brazil's military spending must essentially be explained with reference to internal, economic factors, with a base level determined by a nation with no real external threats, but a constant desire to be seen as a major power, and a massive land area and coastline over which to assert its sovereignty.

These results are again consistent with an institutionalist rather than a utility-maximising understanding for Brazil and Chile, in the sense that these two show at best a tenuous connection between levels of military spending and any actual threat against which such spending might defend.

Military-civil relations vary enormously over the three countries, as was discussed in chapter 5, but the way this is reflected in the empirical results is not necessarily what one might expect given the cross-country results of chapters 3 and 4, or even given considerations of the level of influence retained by the military after handing over power to civilians. A first guess might be that Argentina, where the military retained least influence (see chapter 5), would feel the effects of democracy most greatly, and perhaps Chile the least, with the very high continuing power of the Chilean military post-transition. But what we have is a significant negative coefficient on democracy for Chile, complete insignificance for Brazil, and only the Menem administration showing statistical evidence of lower military expenditure for Argentina.

These results can only make sense when considering the broader aspects of military-civil relations in the three countries, rather than simply the budget. Brazil, though it did not have the most powerful military post-transition, had the most popular one. As we saw in chapter 5, the military could and did credibly wield the explicit or implicit threat of intervention, while civilian politicians were quite willing, within the economic constraints pertaining, to resource the military, using this to establish greater civilian control.

In Argentina, based on the analysis of the previous chapter, we could describe Alfonsin and Menem could as playing "Bad Cop, Good Cop" with the military. Alfonsin hit them hard in many areas, and cut their budget in the face of massive economic difficulties. Menem salved their most serious grievance over human rights prosecutions, but did not give them any share in the nation's return to prosperity. In Chile, the military defended their corner strongly in other areas, but seemed satisfied with the budgetary settlement they'd guaranteed, and didn't demand more as the economy grew. It is interesting to note that the two cases where there are clear negative regime effects, Menem and Chilean democracy, are both cases where there was strong economic growth (except for the Allende period in Chile.) Another point that should be made is that these periods (Menem and post Pinochet), also correspond closely to the post-Cold War period, so it is possible that it is this effect being picked up, rather than a democracy effect (though chapters 3-4 showed no evidence of a specific end of Cold War effect on military spending that could not be picked up by other relevant variables).

The nature of the interaction between Argentina and Chile, long-time regional rivals coming close to war at one stage, is not completely clear. On the one hand, Argentine military spending is clearly influenced positively by Chile's level of military spending the previous year, with only limited evidence of any effect the other way. There is, however, some evidence of a positive influence on military spending of the level of tension between the two countries, suggesting a competitive pattern of military expenditure fuelled by rising tension, which one could reasonably describe, in a broad sense, as an arms race, though it does not fit the classical Richardson model of such.[139]

Overall these results are encouraging in terms of the ability of the model used to explain military spending in these countries, despite the difficulties with data. They also show that, even when considering what appear to be a fairly homogenous set of countries, the differences between their patterns of demand can be as striking as the similarities, so that the precise circumstances of each country must be carefully analysed.

[139] Of course, since all the outstanding border disputes between Argentina have now been solved, and tensions between the two are minimal, it is questionable whether this pattern still pertains.

Table 11: Comparison of results of final reduced form models for Argentina, Brazil and Chile.

+/- = significant, +ve/-ve coefficient, n.s. = not significant, n/a = not applicable.

Dependant variable is log military spending in each case.

Variable	**Argentina**	**Brazil**	**Chile**
Lagged milex	+	+	+
Trend	n.s.	+	+
GDP	+ (1st lag)	n.s.	n.s.
Debt/Debt Service	- (debt 1st lag)	- (debt service 1st lag)	- (debt 1st lag)
Inflation, change	-	-	-
Inflation, lagged level	n.s.	-	-
Rival's milex	+ (Chile, 1st lag)	n.s.	n.s. (Argentina 2nd lag +)
ACCON	n.s.	n/a	Weakly +
Democracy	- (Menem only)	n.s.	-
Other	1983 + (post-war)	Dummies for erratic years	1974 dummy + (Peru tension, 1st year of Pinochet)
Adjusted R^2	.977	.950	.971

Chapter 7: Conclusions

This thesis has investigated empirically the economic, political and strategic factors that determine the demand for military expenditure in developing countries. Three separate econometric approaches have been adopted: cross-section regressions across a large sample of countries, which seek to understand the factors leading to differing military burdens between countries; fixed effects panel data regressions, which look at the factors which, in general, lead to changes in military spending within countries; and time-series regressions for three specific countries, which took the general insights of the first two approaches, but refined them to reflect the particular circumstances of the countries in question.

We shall now attempt to draw together the different strands of this study. First of all we shall briefly review the analysis and conclusions of each chapter. Secondly, we shall look again at the two basic questions posed in chapter 3: have the determinants of military spending changed since the end of the Cold War? And, to what extent to countries respond to military spending by their neighbours and rivals? Alternatively, to what extent are action-reaction arms races a general phenomenon. Finally we shall look again at each of the economic, political and strategic variables that have been considered as potential determinants of military spending, to compare the results of each of the empirical analyses in respect of these variables.

We thus turn now to each of the chapters. In chapter 2, we discussed the different approaches to the demand for military expenditure in the literature, which can be separated into those which analyse the issue in terms of strategic dyadic interactions, and those which start from an economic and political perspective, where external security issues may be one factor amongst many. Amongst the latter, there is a divide between neo-classical models which assume a government rationally dividing national resources between civil and military purposes so as to maximise a utility function, and those such as the institutionalist and Marxist approaches, which see military spending as primarily fulfilling internal political and economic goals, and the interests of power elites.

In Chapter 3, starting from a broadly-defined utility maximisation model, cross-section estimations were performed for the determinants of military burden, during and after the Cold War, taking into account economic, political and security factors. These studies confirmed the initial hypothesis that a country's military burden related to the level of threat it faced, measured by internal and external war, military spending by hostile or potentially hostile powers, and a variety of regional factors. The effect of the level of military spending by non-hostile nations in a country's Security Web was uncertain. National income was found not to affect military burden, so that military spending is roughly proportional to income, while population and democracy both had a negative effect. The latter result was in line with theoretical predictions and the results of most other similar studies. There was little evidence that the pattern of determinants had changed significantly since the end of the Cold War.

Chapter 4 sought to bring a time dimension into the analysis by estimating a Fixed Effects panel data model on the full dataset used in chapter 3. This broadly confirmed the conclusions of chapter 3, showing that the same factors that determine differences in military burden across countries also in general determine differences in military spending within countries. However further analysis found considerable variation in the patterns of determinants between regions, and a clearly significant structural break between the Cold War and Post-Cold War periods, though the meaning of the difference between the periods was not entirely clear.

Chapters 5 and 6 focused in on three countries, Argentina, Brazil and Chile, to investigate how the general conclusions of the previous two chapters could be applied in specific cases. Chapter 5 discussed the economic, political and security issues for these countries over the past 30 years, in relation to how they might have affected military expenditure decisions. Analysis of the differing experiences of transition to democracy by these three countries suggested that the effect of democracy on military expenditure, one of the strongest conclusions of the previous chapters, could be more complex in the South American context, depending on the degree of power and influence retained by the military post transition, and the strategy adopted by the new civilian government towards the military. Chapter 6 estimated time-series models of military expenditure for Argentina, Brazil and Chile, bringing to bear the analysis of the previous chapter. Of these three countries, Argentina was most in line with the results across countries: Argentine military spending depended positively on GDP, negatively on debt and accelerating inflation, positively on Chilean military spending and the Falklands war, and was negatively affected by at least one of the recent civilian regimes. Brazil and Chile on the other hand showed a very different pattern: military expenditure appeared to be unrelated to national income, but instead followed a deterministic upward trend. Debt and inflation had negative effects. Brazil appeared to be unaffected by measurable external security issues, while for Chile there was an ambiguous affect from the conflict with Argentina. The transition to democracy did not affect military expenditure in Brazil, where it is suggested that the civilian regime 'bought' the military's co-operation and gradual subordination to civilian rule with increased budgets. In Chile however, the general picture of democracy reducing military expenditure held, despite the strong institutional power of the military, possibly because the military were satisfied with the minimum level of finance they'd written into the constitution, and did not make an issue of fairly static budgets thereafter, choosing to focus on other issues. Overall, the lack of relationship with GDP and the upward trend in Brazil and Chile suggests that an institutionalist understanding of military spending may be more appropriate to these countries than a utility-maximising one, namely that military spending relates to the institutional power and monopoly of violence enjoyed by the military, rather than a rational allocation of national economic resources.

Having reviewed the results of each chapter, we may turn now to our two questions: the first, relating to changes in the pattern of demand since the end of the Cold War, received an ambiguous answer. In the cross-section model, while there was some reduction in the coefficients of variables relating to threat from neighbours, this could not be found to be statistically significant. In the panel data model however, there was clear evidence of a structural break in the parameters after the end of the Cold War. One way of modelling this break suggested that internal factors had indeed become relatively more important; another model, however, showed changes in a large number of parameters, so that the real significance of this change was not clear.

As to the second question, the proposition that countries increase their military spending in response to increases by hostile powers received very strong support in the cross-section model, the panel data model and the case of Argentina, though the result for Chile was weaker. In the panel data model it was even possible to some extent to control for the effect of changes in the level of hostility of a country's neighbours, as distinct from changes in military expenditure by a given set of rivals, thus further strengthening the conclusion. On the other hand, the effect of military spending by non-hostile neighbours was much weaker: in the cross-section model such an effect was discernible, but the effect of neighbours' military spending could not be distinguished from the effect of their level of income. In the panel data model, the effect of non-hostile neighbours was completely insignificant. This was also found to be so in the specific cases of Argentina and Brazil.[140] This suggests that the presence of either a major regional power on a country's border, or a

[140] Chile has had significant disputes with all of her neighbours, so this does not apply!

large number of smaller powers along a long border, for example, would be a relatively constant factor in a country's security calculus, but not one greatly affected by changes in these neighbours' military spending, at least in the short to medium term.

These two questions were a specific focus the thesis, but we have stressed throughout the importance of a range of economic, political and strategic variables. The three econometric approaches we have taken do not necessarily measure the same effects, and it is therefore interesting to compare the different results obtained by these approaches in respect of each of the variables.

In the utility-maximising approach we have generally taken to modelling military spending, the level of national income is a crucial factor, and whatever model one is using, resource constraints must eventually be a factor. Indeed, in both of the cross-country regressions, and in the fixed-effect model, military spending was found to be roughly proportional to GDP, in other words the income elasticity of demand was not significantly different from one. The panel data showed regional variations in this, with the Western Hemisphere region showing greater than unitary elasticity. The South American case studies however gave a rather different picture: while in Argentina, income was indeed significant, with an elasticity possibly greater than one, in Brazil and Chile, no significant relationship could be found between military spending and GDP, with a deterministic trend being clearly preferred empirically. This could be interpreted as reflecting the powerful military's ability to shield themselves from the economic cycle.

Turning to other economic factors, debt was only used in the case studies. In all three, a negative effect of debt on military spending was detected, either through debt stocks or debt service levels. Inflation was likewise only used in the case studies, and was found to have a negative impact on military spending in all three.

The overall level of trade was included in the cross-section and panel data studies. This was insignificant in the cross-section models, but weakly negative in the fixed effects model. This could be interpreted as reflecting the lower inclination of countries that trade heavily with each other to go to war. Another variable which can be interpreted both politically and economically is population, which was found to have a strongly negative effect in both the cross-section and panel data models. It was suggested that this is because high populations have proportionately greater civil needs as opposed to military needs. However in most of the regional panels and in the specific country studies, no significant effect was picked up.

Moving onto strategic variables, in both the cross-section and panel data, external and civil war both had a significant positive effect; the exception was external war in the post-cold war period, where the effect was insignificant, possibly due to lack of variation in the variable. In the case studies, only one country, Argentina, was involved in what could properly be called a war, either external or civil, namely the Falklands/Malvinas conflict with the UK. This had a clear positive effect on their military spending. We have already discussed the effects of neighbours' military spending. The spending of hostile neighbours had an almost universally positive effect on military spending, in both cross-section models, in the panel data model, and somewhat less clearly in the case studies. The effect of other neighbours' military spending however was at best weak and ambiguous, and frequently completely insignificant.

Finally we turn to political variables, specifically the level of democracy. The cross-section and panel data studies, in common with other studies such as Rosh (1988) and Hewitt (1991), both found that more democratic governments tend to spend less on the military. This was also true for all of the regional panels except the Middle East. However when this was taken down to the level of the individual case studies, all three countries which had undergone major political transitions, the picture became more muddied. Only Chile showed a clear negative effect for the democratic transition, at first sight somewhat surprisingly given the degree of power retained by the military. In Argentina, where the military was weakest post-transition, a statistically significant effect could only be detected for the Menem regime, who compensated the military by ending human rights prosecutions (and pardoning convicted generals), and boosting their self-esteem with a meaningful peace-keeping role. In Brazil, where like Chile the military retained considerable power, there was no significant effect; indeed, military spending rose in absolute terms and as a share of GDP as the military were 'bought off' in return for accepting increasing subordination to civilian authority. Thus, while the democracy effect in reducing military spending is very robust in the generality, it is necessary to look at the specific situation in each country to gauge the effect on military spending of political transition.

The overall picture that emerges from most of this is in many ways remarkably consistent with traditional theoretical models of military expenditure, such as Smith (1980): a government, facing a resource constraint (proxied by GDP, debt or both), must divide the nation's resources between security and (public or private) civil expenditure. The amount devoted to security will depend on the threat, external or internal, that military expenditure may be guarding against. This threat may be measured by state of war, by the military expenditure of (particularly hostile) neighbours, and possibly by levels of tension with long-standing rivals.

The political effects proxied by democracy and/or regime variables complicate the picture somewhat. At one level, the negative coefficient on democracy in many models could simply reflect differing perceptions of the balance between security and civil expenditure between military and civilian regimes. However analysis of the case studies suggests that military expenditure may represent in part a 'rent' claimed by the military on the basis of their institutional and physical power, to reward themselves and their allies. In Brazil and Chile, we may see this effect to some extent persisting beyond their stay in power – the guaranteed budgetary minimum and share of copper revenues is highly inflexible with respect to changing economic and security circumstances (unlike the classical 'public good' model), and would seem more to represent the military guaranteeing their own interests within society. In Brazil, the military's rent-levying capability lay more in the threat of disquiet in the barracks at low salaries, and ultimately the threat of possible military intervention.

However what emerges very clearly from these studies is that military expenditure is best modelled as a function of a wide variety of factors, economic, political and external, rather than purely in terms of a dyadic arms race. Within this, there is clearly room for examining many more factors than have been used here, and many more econometric techniques. We may also expect the influencing variables to operate very differently in different settings, as was shown by the very different patterns even in three countries in the same region, and with many similar political and economic experiences.

While there is a great deal of variation between the dynamics of military spending in different countries and regions, the overall picture from this thesis provides some reassuring degree of consistency. The question "Why do some countries have higher military burdens than others" (addressed by the cross-section studies) has a similar answer to the question "Why, in general, does a country's military spending rise or fall over time" (addressed by the panel data study). When this is taken down to the country or regional level, the picture becomes more complex, but can still be seen as a reflection of the overall pattern.

Chapter 8: Suggestions for further research.

There are a number of ways in which the research presented in this thesis could be developed:

1) Chapters 3 and 4 are fairly limited in their treatment of economic variables. In particular, levels of debt or debt service, which proved to be highly significant in the South American case studies, could be added to the model.
2) The panel data study of chapter 4 used a Fixed Effects estimator in levels. This could be extended by using dynamic panel techniques to gain a better understanding of the short-run adjustment processes for military spending in developing countries.
3) The analysis of chapter 5 suggested that the continuing influence of the military, and the strategy adopted towards them by the civilian government could be important in terms of whether transition to democracy leads to reduced military spending. Attempts could be made to test this more explicitly by developing proxies for military influence and, if possible, government strategy.
4) It would also be interesting to attempt to develop a formal model to analyse the institutional aspects of military expenditure in the South American case studies, specifically modelling factors such as military influence and the desire of a civilian government to secure the military's co-operation.
5) Continuing military influence after transition to democracy is likely to vary more across countries than across time. More insights might therefore be gained from a variable for military influence if a larger sample of Latin American countries could be studied, leading perhaps to a panel data model. This would, however, require considerable effort in data gathering.

Appendix 1: Table of Security Webs of Countries in the sample for chapter 3

Table 1 below lists the Security Web, Potential Enemies and Enemies of each country in the study, as well as the External and Civil War status of each country. The Great Power Enemy status is also noted. Lists of countries relating to some of the other security variables are also given below. Note that many of the countries listed in the table were included in only one sample: firstly, many countries came into existence in the Post Cold War period (while South Yemen disappeared), and secondly, in many cases sufficient military spending data was only available for one sample (usually Post Cold War). A country was included in a particular sample provided that military spending data was available for at least five of the eight years in the period. The table notes which countries are only included in one sample.

Unquantified Threat

As has been noted, there were a few countries for whom military spending data was so completely lacking that it did not seem reasonable to include figures for their expenditure in their neighbours' Security Web totals. These countries were classified as an "Unquantifiable Threat". In an attempt to partially quantify this, a variable UQT was constructed for each country in the sample, which totalled the population of "Unquantifiable Threat" countries in their Security Web, multiplied by two if the country was a Potential Enemy and by four if they were an Enemy. The UQT variable never proved significant in any estimation. The countries classified as Unquantifiable Threats are as follows:

Afghanistan 1989-97

Angola 1981-82

Cambodia 1981-90

Cape Verde 1984-88

Laos 1981-82, 1987-90

Lebanon 1987-88

Liberia 1989-97

Somalia 1991-97

Vietnam 1981-85, 1987-88

China

In the initial specification, China was excluded from the Security Web of all countries except India and Taiwan. Instead, a China Proximity dummy was set to one in all of China's neighbours (except India and Taiwan), and all countries bordering the South China Sea. In the case of South Korea and Vietnam, the Great Power Enemy variable was credited with an extra 0.5. In a subsequent specification, China's military expenditure was included in the Security Web totals.

The China dummy was set to one for the following countries:

Brunei, Burma, Cambodia, Indonesia, Kazakhstan, North Korea, South Korea, Kyrgyzstan, Laos, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Singapore, Thailand, Vietnam.

USA and USSR/Russia

The military expenditure of the USSR, Russia and the USA was excluded from all Security Web totals, except for China, for whom the Soviet Union was included. USA and

USSR proximity dummies were constructed for neighbouring countries or those in the direct sphere of influence. The USSR dummy represents either USSR or Russia proximity, and its value changes for some countries. The relevant countries are:

USA: Barbados, Belize, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Trinidad & Tobago.

USSR: Azerbaijan, Georgia, Iran (till 1991), Kazakhstan, Kyrgyzstan, Mongolia, Pakistan (till 1991), Tajikistan, Turkey, Uzbekistan.

The USSR and USA dummies were never significant.

Middle East

The following countries were classified as being in the Middle East and had the Middle East dummy set to one:

Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen (North Yemen till 1990), South Yemen.

Table 5: Security Webs and External and Civil War status of countries in either of the two samples

(Countries are in both samples unless otherwise stated.)

Where a country is bracketed as part of a Security Web/Enemies etc., its milex has not been included in the relevant total, though in most cases an appropriate dummy will have been switched on.

Country	Enemies	Potential Enemies	Other Security Web[i]	External War[ii]	Civil War[iii]
Algeria		Morocco 1973-88	Libya, Mali, Mauritania, Niger, Tunisia		(2) 1988-91 (3) 92-97
Angola (Post Cold War only)			South Africa, Zambia, DRC, Congo (Brazzaville), Namibia (from 1990)		(3) 90-92 (4) 1993-94 (2) 1995-96 (3) 1997
Argentina	(UK 1982-89:GPE=.5)	(UK 81, 90-97), Chile 1981-84	Brazil, Uruguay, Bolivia	1982	
Azerbaijan (Post CW only)	Armenia 1991-97		Georgia, Iran, Turkey	1991-94	(4)1991-94 (1)1995-97
Bahrain		Qatar 1986-91, Iraq[iv] 1990-97	Saudi Arabia		
Bangladesh		Burma 1981-97	India		(3) 81-87 (1) 88-97
Barbados			None		
Belize		Guatemala 1981-91	Mexico		
Benin			Burkina Faso, Niger, Nigeria, Togo		
Bolivia		Chile 1981-97, Peru 1981-97	Argentina, Brazil, Paraguay		
Botswana			South Africa, Zambia, Zimbabwe, Namibia (from 1990)		
Brazil			Argentina, Bolivia, Colombia, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuala		
Brunei (Post CW only)			Indonesia, Malaysia		
Burkina Faso	Mali 1985-86	Mali 1981-84, 87-96	Ghana, Ivory Coast, Benin, Niger, Nigeria, Togo		
Burma		Bangladesh 1981-97	India, Laos, Thailand, (China)[v]		(3) 1981-91 (4) 1992 (3) 1993 (4) 1994 (3) 1995-97

Burundi			DRC, Rwanda, Tanzania		(4) 1988, 1993-97
Cambodia (Post CW only		Thailand 1990-97	Laos, Vietnam		(4) 1990 (2) 1991-97
Cameroon		Nigeria 1990-97	CAR, Chad, Congo (Brazzaville), Equatorial Guinea, Gabon		
CAR			Camerron, Chad, DRC, Congo (Brazaville), Sudan		
Chad	Libya 83-94, Nigeria 1983	Nigeria 1984-93	Cameroon, CAR,Niger, Sudan		(1) 81 (4) 82-89 (1) 90 (3) 91-94 (2) 95-97
Chile		Argentina 1981-84, Bolivia 1981-97	Peru		
China	India 1981-93 Taiwan: 1981-97 Vietnam 1981-90	USSR 1981-91, Vietnam 1991-97, Afghanistan 1981-88	Burma, North Korea, South Korea, Mongolia, Nepal, Pakistan, Bhutan		
Colombia		Venezuala 1981-97	Brazil, Panama, Ecuador, Peru		(3) 81-97
Congo (Brazaville)			Angola, Cameroon, CAR, DRC, Gabon , Nigeria		(3) 1993-95 (4) 1997
Costa Rica		Nicaragua 85	Panama		
Cuba	(USA 1981-97 : GPE=1) South Africa[vi] 1981-88		Dominican Republic, Haiti		
Cyprus	Turkey 1981-97		Greece		(1) 81-97
Djibouti (Post CW only)			Ethiopia, Somalia, Yemen		(3) 1991-94
Dominican Republic			Cuba, Haiti		
Ecuador	Peru 1981-97		Colombia	1981, 1995	
Egypt		Sudan 1992-97, Iraq[ii] 1990-91, Libya 1981-87	Israel, Jordan, Saudi Arabia		(2) 1988-99
El Salvador		Honduras 1981-87	Guatemala		(4) 1981-1992
Ethiopia	Somalia 1981-88	Sudan 1981-86	Kenya, South Yemen (until 1989), Yemen (from 1990), Eritrea (from 1993)		(4) 198-91 (1) 1992-97
Fiji			None		
Gabon			Cameroon, Congo (Brazzaville), Equatorial Guinea, Nigeria		
Gambia (Post CW only)			Senegal		

Georgia (Post CW only)					(2) 1991-92 (3) 93 (1) 94-97
Ghana		Togo 1993-94	Burkina Faso, Nigeria, Ivory Coast		(3) 1994-97
Guatemala		Belize 1981-91	El Salvador, Honduras, Mexico		(4) 1981-97
Guinea (Post CW only)			Guinea Bissau, Ivory Coast, Nigeria, Mali, Senegal, Sierra Leone, Liberia		
Guinea Bissau			Guinea, Senegal		
Guyana			Venezuala, Brazil, Suriname		
Haiti			Dominican Republic, Cuba		(3) 1991-94
Honduras		El Salvador 1981-87	Guatemala, Belize, Nicaragua		
India	China 1981-93 Pakistan 1981-97	Afghanistan 1981-88	Bhutan, Burma, Nepal, Sri Lanka		(3) 1981-87 (4) 88-97
Indonesia			Malaysia, Papua New Guinea, Philippines, (China)[iii]		(4) 1981-97[vii]
Iran	Iraq 1981-97, Saudi Arabia 1987, (USA 1981-97:GPE=1)	Saudi Arabia 1988-96, Turkey 1991-97	Pakistan	1981-88	(3) 81 (2) 82-88 (1) 92-97
Iraq	Israel 1981-97, Iran 1981-97, Kuwait 1990-97, Saudi 1990-97, Syria 1990-97, Turkey 1990-97, (USA 1990-97: GPE=1)	Bahrain, Oman, Qatar, UAE 1990-97, Egypt 1990-91		1981-88, 1990-91	(4) 1981-86 (4) 1991 (2) 1992-97
Israel	Iraq 1981-97 Syria 1981-97 Jordan 1981-94, Lebanon 1982-97	Saudi 1981-97, Lebanon 1981		=1:1982-85; =.5 1986-97	(2) 1987-93
Ivory Coast			Burkina Faso, Ghana, Guinea, Liberia, Nigeria,Mali		
Jamaica			None		
Jordan	Israel 1981-94		Egypt, Iraq, Syria		
Kazakhstan (Post CW only)			Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan		
Kenya		Uganda 1987-89	Ethiopia, Somali, Sudan, Tanzania		(1) 1991-97
Korea, North	South Korea 1981-97, (USA 1981-97: GPE=1)		China		
Korea, South	North Korea 1981-97	(China 1981-97: GPE=.5)[iii]			

Kuwait	Iraq 1990-97		Iran, Saudi Arabia	1990-91	
Kyrgyzstan (Post CW only)			Kazakhstan, Tajikistan, Uzbekistan, (China)[iii]		
Laos (Post CW only)		Thailand 1981-92	(China)[iii], Burma, Cambodia, Vietnam		
Lebanon	Israel 1982-97	Israel 1981	Syria		(4) 1981-90 (2) 1991-97
Lesotho (Post CW only)			South Africa		
Liberia (Cold War only)			Guinea, Ivory Coast, Nigeria, Sierra Leone		(4) 1989-95
Libya	Chad 1983-94	Egypt 1981-87 (USA 1981-97: GPE=1)	Algeria, Niger, Sudan, Tunisia	1981-89	
Madagascar			None		
Malawi		Zambia 1981-86	Mozambique, Tanzania		
Malaysia			Indonesia, Philippines, Thailand (China)[iii]		
Mali	Burkina Faso 1985-86	Burkina Faso 1981-84, 1985-96	Algeria, Guinea, Ivory Coast, Mauritania, Niger, Nigeria, Senegal		(2) 1990-94
Mauritania	Senegal 1989-90	Senegal 1991-97	Algeria, Mali, Morocco		
Mauritius			None		
Mexico			Belize, Guatemala		(2) 1994-97
Mongolia			(China)[iii]		
Morocco		Algeria 1981-88	Mauritania	1981-91[viii]	
Mozambique	South Africa 1981-84	South Africa 1985-90	Malawi, Tanzania, Zambia, Zimbabwe		(4) 81-92 (1) 93-94
Namibia (Post CW only)			Angola, Botswana, South Africa, Zambia, Zimbabwe		
Nepal			(India) (China)		(1) 1987-97
Nicaragua		Costa Rica 1985, (USA 1981-90:GPE=1)	Honduras		(4) 81-90 (2) 1991-94
Niger			Algeria, Benin, Burkina Faso, Cameroon, Chad, Libya, Mali, Nigeria		(3) 1990-95
Nigeria	Chad 1983	Chad 1984-97, Cameroon 1991-97	Benin, Niger		(3) 1993-97
Oman		Iraq 1990-97[ix] S. Yemen (Aden) 1981-89 Yemen 1990-92	Saudi Arabia, UAE		
Pakistan	India 1981-97	Afghanistan 1981-97	Iran		(3) 1981-97
Panama	(USA 1989:GPE=1)		Colombia, Costa Rica		

Papua New Guinea			Indonesia		(3) 1988-97
Paraguay			Argentina, Bolivia, Brazil		
Peru	Ecuador 1981-97	Bolivia 1981-97	Brazil, Chile, Colombia	1981, 1995	(4) 1981-96 (2) 97
Philippines			Indonesia, Malaysia (China)[iii]		(3) 1981-97
Qatar (Post CW only)		Bahrain 1986-91 Iraq 1990-97 Saudi Arabia 1990-97			
Rwanda			Burundi, DRC, Tanzania, Uganda		(4) 1990-94 (3) 1995-97
Saudi Arabia	Iran 1987 Iraq 1990-97	Iran 1988-96 Qatar 1990-97 Yemen: 1992-97 Israel 1981-97	Bahrain, Jordan, Egypt, UAE		
Senegal	Mauritania 1990-91	Mauritania 1992-97	Gambia, Guinea, Guinea Bissau, Mali		(3) 1982-97
Sierra Leone			Guinea, Liberia, Nigeria		(4) 1991-97
Singapore			Indonesia, Malaysia (China)[iii]		
Somalia (Cold War only)	Ethiopia 1981-88		Kenya		(4) 1988-97
South Africa	Angola 1981-88, Cuba 1981-88[x] Mozambique 81-84	Mozambique 85-90 Zimbabwe 1981-90 Zambia 1981-90	Botswana, Swaziland, Lesotho, Namibia (from 1990)		(3) 90-94
Sri Lanka			India		(4) 1983-97
Sudan	Uganda 1992-97	Egypt 1992-97 Eritrea 1994-97 Ethiopia 1981-86	CAR, Chad, Kenya, Libya, DRC, Uganda		(4) 1983-97
Suriname (Post CW only)			Brazil, Guyana		(3) 1986-92 (2) 94-97
Swaziland (Post CW only)			Mozambique, South Africa		
Syria	Israel 1981-97 Iraq 1990-97	Turkey 1990-97	Jordan, Lebanon	1982, 1990-91	(3) 1982
Taiwan	China 1981-97				
Tajikistan			Afghanistan, Kyrgyzstan, Pakistan, Uzbekistan, (China)[iii]		(1) 1990-91 (4) 1992 (3) 1993-97
Tanzania			Burundi, Kenya, DRC, Rwanda, Mozambique, Zambia, Uganda		

Thailand	Cambodia 1981-87 Laos 1983-88 Vietnam 1981-87	Laos 1981-82, 89-92	Cambodia 1988-97		(1) 91-92
Togo		Ghana 1993-94	Benin, Burkina Faso, Nigeria		(2) 1991-94
Trinidad & Tobago (Post CW only)			None		
Tunisia			Algeria, Libya		(2) 1981-87
Turkey	Greece 1981-97 Cyprus 1981-97 Iraq 1990-97	Syria 1990-97, (USSR 1981-90:GPE=1)	Iran, Georgia (from 1992), Armenia (from 1992)		(1) 1984-88 (3) 1989-97
UAE		Iraq 1990-97[xi]	Oman, Saudi Arabia		
Uganda	Sudan 1992-97	Kenya 1987-89	DRC, Rwanda, Tanzania		(2) 1981-86 89-91, (3) 94-97
Uruguay			Argentina, Brazil		
Uzbekistan (Post CW only)			Kazakhstan, Kyrgyzstan, Tajikistan		
Venezuala		Colombia 1981-97	Brazil, Guyana	1981-90	
Vietnam (Post CW only)	(China 1981-97)[iii], (USA 1981-90); GPE=1.5 to 90, =0.5 91-97; Thailand 1981-87	Thailand 1988-97	Laos, Cambodia		
Yemen (North Yemen till 1990)		Eritrea 1995-97, Saudi 1992-97, Oman 1990-92, South Yemen 1981-89			(1) 1991-93 (4) 94 (1) 95-97
South Yemen (Aden) (Post CW only)		Oman 1981-89, North Yemen 1981-89	Ethiopia, Saudi Arabia		(4) 1986
Zaire (DRC) (Cold War only)		Zambia 1983-87	Angola, Burundi, Congo(Brazzaville), Rwanda, Sudan, Tanzania, Uganda		(3) 91-95 (4) 96-97
Zambia (Post CW only)	Zaire/DRC 1981-82	Zaire/DRC 1983-87 Malawi 1981-86 Zimbabwe 1981-87, South Africa 1981-90	Angola, Botswana, Mozambique		
Zimbabwe		South Africa 1981-90 Zambia 1981-87	Botswana, Mozambique, Namibia (from 1990)		(2) 1983

[i] Except where otherwise stated, countries listed in the Enemies or Potential Enemies column for some years are part of the Security Web for the remainder of the relevant period.

[ii] Lists years for which External War dummy is set to 1. (Occasionally to 0.5, where stated.)
[iii] Lists years when Civil War variable is set to a given level, (1) to (4). Variable set to 0 for all other years.
[iv] The classification of Enemies and Potential Enemies of Iraq was troublesome; to classify every country that was part of the multi-national force as an enemy would seem excessive; in addition, countries bordering Iraq might not see such a pressing continuing security threat from Iraq after the end of the Gulf War. What I have done is to classify Kuwait, Saudi Arabia, Syria and Turkey, being neighbours and important participants, as enemies from 1990 onwards, the other Gulf states: Bahrain, Qatar, Oman and UAE as Potential Enemies from 1990 onwards, and Egypt, as a more distant participant, as a Potential Enemy for 1990-91 only, with Iraq and Egypt not in each others' Security Web thereafter. Israel and Iran were both Enemies of Iraq throughout 1981-97 for other reasons. Clearly alternative classifications to these could reasonably be used.
[v] In the initial specification, China was not included in the Security Web for these countries, but the China dummy was set to 1.
[vi] South Africa and Cuba are only included in each others' Security Web while they are enemies.

[vii] Resulting from a combination of the East Timor, West Papua and Aceh conflicts, though individually they probably fall below the level 4 threshold. East Timor is counted as an internal conflict, as this is how Indonesia would see it, and as this seems a better representation of the character of the war, i.e. a guerrilla insurgency. (I would have classified the war as external from 1976-77, during the initial conquest of the territory.)
[viii] I have treated the war between Morocco and the Polisario Front as an External War rather than a Civil War (in contradistinction to the East Timor conflict) as this seemed to better represent the nature of the warfare in this case.
[ix] Iraq is not in Oman's Security Web prior to 1990
[x] Cuba and South Africa are only included in each others' Security Webs when they are enemies.
[xi] Iraq is not in UAE's Security Web before 1990.

Appendix 2: Data for military expenditure and other variables for chapters 3-4.

A2.1 Military expenditure data

The sources for the military expenditure data for the case studies of Argentina, Brazil and Chile in chapters 5 and 6 have already been discussed in section 5.3.

The military expenditure data used in chapters 3 and 4 is from the US Arms Control and Disarmament Agency (ACDA) *World Military Expenditures and Arms Transfers* for 1991-92 (for 1981-88) and 1998 (for 1990-97). (in chapter 4, the latter edition was used for data from 1987 onwards.)

A full description of the sources and methods used by ACDA is given in for example ACDA (2000). ACDA state that for most non-NATO, non-communist countries, the military expenditure figures represent the expenditure of the country's Ministry of Defence. This of itself means that the figures do not represent any single definition of military expenditure, as different countries include or exclude different items from their MoD budgets. Military pensions is a good example of an item that may be included in the Ministry of Defence budgets of some countries, and the Social Security budgets of others. In addition, as ACDA(2000) discusses, there is often a lack of transparency in defence budgeting, so that official figures may be underestimated due to the use of double book-keeping, extra-budgetary accounts, etc. It is not uncommon for the military to be able to use the proceeds of military-run industries for arms purchases, for example, and these may well not be included in the Ministry of Defence budget. The copper revenues used to fund Chilean arms purchases is a case in point. (See chapter 5). In the case of many communist countries, and others where military spending is highly non-transparent, the ACDA figures are based on intelligence estimates, whose provenance and inclusivity cannot be known. ACDA also use, on occasions, secondary sources such as the IMF *Government Financial Statistics Yearbook*, the International Institute for Strategic Studies *Military Balance*, and the SIPRI Yearbook.

All of this introduces a significant source of error especially for cross-country comparisons. For within-country comparisons, such as arise from the Fixed Effects Model of chapter 4, it may at least reasonably be hoped that the series for particular countries are fairly consistent, though the re-estimation that frequently took place between the two ACDA yearbooks used means this is not entirely the case.

It should be noted that all sources of military expenditure data is subject to this type of difficulty, and that no source can claim to provide information that is wholly consistent across countries and across time. This is a fact of which the author, who now works on collecting military expenditure data for SIPRI, is only too painfully aware.

A2.2 Alphabetical list of variables and data sources for chapters 3-4

Variable	Description	Source
China	=1 if country borders China or the South China Sea	See Appendix 1
Civil War	Ranges from 0 (no internal armed conflict) to 4 (full-scale civil war) for each country-year	See Appendix 1, also note below.
Democracy	A measure of institutional democracy in a country in a given year	Polity 98 database of democracy. The most recent version of this database can be found at http://weber.ucsd.edu/~kgledits/Polity.html
Enemies Milex	Aggregate military expenditure of all a country's Enemies	Compiled from ACDA military spending data using classification from Appendix 1, also below.
External War	1 if a country is involved in an interstate war in a given year, 0 otherwise	See Appendix 1, also note below .
GNP	Gross National Product	ACDA Yearbook
Great Power Enemy	=1 if a country is an enemy of a Superpower in a given year. (0.5 for other major powers). 0 otherwise	See Appendix 1, also note below.
Land areas, borders, coastline	Self-explanatory	Taken from CIA World Factbook 2000.
Middle East	=1 if country is in the Middle East region, 0 otherwise	See Appendix 1
Military burden	Military expenditue/GNP	ACDA Yearbook, see above
Population	Self-explanatory	ACDA Yearbook
Potential Enemies Milex	Aggregate military expenditure of all a country's Potential Enemies	Compiled from ACDA military spending data using classification from Appendix 1, also below.
Security Web etc. income	Aggregate GNP of states in a country's Security Web (Potential Enemies, Enemies) for a given year.	GNP data from ACDA, with classifications from Appendix 1.
Security Web milex	Aggregate military expenditure of all countries in a given country's Security Web	Compiled from ACDA military spending data using classification of Security Webs from Appendix 1
Trade	Total imports plus exports	ACDA Yearbook.
Unquantified Threat	A proxy for missing data in a country's Security Web, equal to the population of countries in the SW for whom milex data is missing, multiplied by 2 for Potential Enemies, 4 for Enemies	Population and (lack of) milex data from ACDA. List of countries treated as 'Unquantified threats' given in Appendix 1.
USA	=1 if country is in Central America and the Caribbean	See Appendix 1
USSR	=1 if country borders USSR (Russia from 1992)	See Appendix 1

NB: the classification of each country's Security Web, Potential Enemies and Enemies, as well as the value of their External War, Civil War and Great Power Enemy variables, was based on information on conflicts from the following sources:

1) The KOSIMO database of violent and non-violent conflicts, produced by the Heidelberg Institute of International Conflict Research (HIIK), which can be accessed at http://first.sipri.org/.
2) The Dyadmid database of dyadic interstate conflicts, produced by Professor Zeev Maoz of Tel-Aviv University, which can be accessed at http://spirit.tau.ac.il/zeevmaoz/dyadmid.html.
3) The CASCON database of conflict case studies, produced by Professor Lincoln P. Bloomfield of the Massachusetts Institute of Technology, available at http://web.mit.edu/cascon/.
4) The Conflict Data Project of the Uppsala Department of Peace and Conflict Research, which can be accessed at http://www.pcr.uu.se/.

Appendix 3: A chronology of major events in Argentina, Brazil and Chile

Argentina

1966: Military seize power.

1971: New military ruler announces return to civilian rule with elections for March 1973.

1973: Build-up to elections marked by rioting, strikes and left-wing terrorist activity. Peronist Justicia Party wins election, with Hector Campora becoming President. Former ruler Juan Peron returns from exile, takes over presidency in September following Campora's resignation. Continuing violence by left and right-wing groups.

1974: Peron dies in July, succeeded by his wife and Vice-President, Isobel.

1975: 700 killed in political violence. Economic stagnation and rising inflation.

1976: Military coup led by General Jorge Videla, inaugurating 'Proceso' regime. Legislature dissolved, martial law and rule by decree declared. Massive repression against political opponents.

1977: Argentine Commission for Human Rights in Geneva reports 2,300 political murders and 20-30,000 people 'disappeared' in military regime's 'Dirty War''. International commission finds for Chile in Beagle Channel dispute.

1978: Argentina rejects Commission ruling on Beagle Channel. War with Chile looms.

1979: Argentina & Chile agree to Papal mediation over Beagle Channel, averting war.

1981: Severe recession. Videla succeeded by Gen. Roberto Viola, in turn deposed by Gen. Leopoldo Galtieri.

1982: Worsening economic problems and growing unpopularity of regime. Argentina invades UK Falklands/Malvinas islands in April. UK recaptures islands in June after short war. Galtieri resigns, succeeded by Maj. Gen. Bignone, who announces return to civilian rule. Mexican default precipitates 3rd World debt crisis.

1983: Radical Party candidate Raul Alfonsin elected President, takes over in December

1984: Alfonsin purges senior ranks, cuts military spending, initiates prosecutions of Junta leaders for human rights abuses and incompetence in war. Civilian Ministry of Defence takes over defence policymaking. Treaty of Peace & Friendship with Chile settles Beagle Channel dispute.

1985: Hyperinflation leads to Plan Australe, with wage & price freezes.

1986: Junta leaders sentenced to jail terms for roles in Dirty War and Falklands failure.

1987: Right-wing officers mutiny against human rights prosecutions at Easter. Rebellion defeated, but government makes compromises.

1988: Two more mutinies by right-wing officers.

1989: Severe economic crisis. Peronist candidate Carlos Menem elected President, Alfonsin agrees to hand over early in face of crisis.

1990: Economy begins to improve. Menem pardons officers convicted of human rights abuses, but cuts military budget. Another mutiny is swiftly put down.

1991: Presidents Menem of Argentina and Aylwin of Chile agree to settle all remaining border disputes. Mercusor trade pact between Argentina, Brazil, Paraguay and Uruguay.

1994: Menem wins additional term of office.

Brazil

1964: Military coup. Congress remains, but with reduced powers.

1969: Congress elects Emilio Medici President, heralding harsh crackdown on opposition, with severe human rights abuses.

1974: Election of Ernesto Geisel as President heralds political opening process.

1979: Last military ruler, Joao Figueirido comes to power, restores political rights to thousands of prisoners, exiles and others.

1982: Free elections to Congress and regional governorships. Mexican default precipitates 3rd World debt crisis. High interest rates and falling commodity prices worsen debt situation.

1985: Military hands over power, as opposition leader Tancredo Neves elected President by electoral college. He dies before taking office, and his deputy Jose Sarney becomes President.

1987: Brazil suspends repayments on foreign debt.

1987-88: Growing economic crisis and social unrest. Military used to put down strikes. Increasing violence by landowners and right-wing groups against landless peasants movement and environmentalists.

1988: New Constitution agreed by Constituent Assembly. Military loses absolute right to intervene in domestic politics, but retains power to do so if requested by any single 'constituted power'. Murder of environmentalist Chico Mendes draws international condemnation.

1989: Centre-right candidate Fernando Collor defeats left-wing Lula de Silva to become President.

1991: Mercusor trade pact between Argentina, Brazil, Paraguay and Uruguay. Brazil affected by spillovers from Colombian civil war. Troops clash regularly with 'gold diggers' from Venezuala.

1992: President Collor impeached for corruption, replaced by Deputy Itamar Franco. Rio Earth Summit heightens concerns over Amazon and fear of 'Internationalisation'.

1988-1993: Brazilian economy plagued by hyperinflation.

1994: Centrist Fernando Cardoso defeats Lula de Silva to become President. New currency introduced to tackle hyperinflation. Military launch operation against drug-dealers in Rio slums.

1999: Cardoso wins a second term of office.

Chile

1970: Salvador Allende, head of left-wing Popular Unity Party, elected President. Embarks upon programme of widespread nationalisation of industry.

1972: US economic pressure contributes to economic crisis. Allende reforms stalled by centre-right Congress.

1973: Street violence from right and left-wing groups as economy worsens. US-backed Military coup on September 11th brings General Augusto Pinochet to power. Allende commits suicide. Congress closed, media censored, political parties and unions banned.

1973-77: Most human rights violations committed in this period. Widespread torture, disappearances and murder by regime. Subsequent report details over 3,000 killed.

1976: Pinochet's economic 'shock therapy' leads to severe recession. Strong growth follows in subsequent years.

1977: Pinochet institutionalises military rule, but announces eventual controlled return to civilian rule. International commission finds for Chile in Beagle Channel dispute with Argentina.

1978: Amnesty law covers all human rights abuses up to this point. War looms as Argentina rejects Beagle Channel ruling.

1979: Argentina & Chile agree to Papal mediation over Beagle Channel, averting war.

1980: New Constitution enshrines military privileges. Plebiscite to be held in 1988 on continuing Pinochet rule.

1982: Mexican default precipitates 3rd World debt crisis. Severe recession. Widespread regular protests against government.

1983: Frente Populare Manuel Rodriguez formed, launches urban guerrilla campaign against Pinochet.

1984: Treaty of Peace & Friendship with Argentina settles Beagle Channel dispute.

1986: Attempt on Pinochet's life provokes severe crackdown.

1988: Plebiscite on continuing military rule results in 57% 'No' vote. Military prepares to hand over power.

1989: Centre-Left 'Concertation' party of Christian Democrats and Socialists wins elections. Christian Democrat Patricio Aylwin becomes President. Military retain considerable influence. Pinochet remains head of Army.

1990: Aylwin sets up Rettig Commission to report on human rights abuses under Pinochet regime. Economy enjoys strong, stable growth throughout 1990s.

1991: Rettig commission reports. Over 3,000 killed in abuses under military rule. Moves begin for further investigations, stripping away amnesty laws. Presidents Menem of Argentina and Aylwin of Chile agree to settle all remaining border disputes.

1994: Eduardo Frei of Concertation Party elected President.

1998: Pinochet retires as chief of Army, becomes Senator for Life.

Sources for Argentina used: http://www.shadow.net/~giorgio/argentina.html#History (taken from Encarta encyclopedia), Martinus (1988), Latin American Weekly Reports, Fitch (2000), Hunter (1996).

Sources for Brazil used: http://www.wikipedia.com/wiki/History+of+Brazil , Latin American Weekly Reports

Sources for Chile: Countrywatch.com entry for Chile Political History at http://www.countrywatch.com/cw_topic.asp?vCOUNTRY=36&SECTION=COVER&TOPIC=POHIS&TYPE=TEXT. , Latin American Weekly Reports

Appendix 4: Data tables for South America

Table 1: Argentina

Date	Military spending (m 1995 pesos)	GDP (m 1995 Pesos)	Debt ($m1995)	Debt Service ($m1995)	Inflation (%)	Democracy (Dem-Aut from Polity 98)
1970	5927	163649.1	21347.31		6.5	-9
1971	5893	172908.5	21750.62	3477.284	31	-9
1972	6064	175723.7	22516.39	3508.215	64	-9
1973	6354	180664.3	22586.18	4022.07	66	6
1974	6464	190662	21977.4	4431.919	31	6
1975	8201	190608	20369.99	3947.31	198	6
1976	9276	186761.3	22973.84	3732.443	438	-9
1977	9813	199711.2	26516.68	3996.877	159	-9
1978	10504	190712.1	28586.99	6661.225	161	-9
1979	10894	210207.9	41429.23	4165.896	147	-9
1980	9695	218936.2	49039.27	7062.592	91	-9
1981	10306	206479	58360.47	8256.247	106	-8
1982	8897	196243.7	67318.97	7039.498	208	-8
1983	10171	203848.1	67807.66	9405.366	382	8
1984	8065	208357.5	68961	8294.027	607	8
1985	6912	192550.1	69466.9	7917.523	626	8
1986	6923	207715.1	69808.63	9115.577	74	8
1987	7482	213759.4	75311.56	7523.786	127	8
1988	7548	208293.9	72998.88	5837.147	388	8
1989	6141	192679.7	77557.04	4878.293	3058	8
1990	4206	188057.3	70887.62	6594.554	2077	8
1991	4056	211883.6	71731.5	5614.869	133	8
1992	3841	237183.7	73014.3	4912.2	12	8
1993	3623	251194.1	67311.26	5746.69	-1.5	8
1994	4157	265854.3	76443.45	5585.659	2.8	8
1995	4361	258290.2	98802.09	8406.44	3.2	8
1996	4136	272565.1	110169	12082.19	-0.05	8
1997	3989	294673	126438.3	16873.92	-0.46	8
1998	3899	306161.7	137985.7	19684.83	-2	8
1999	4130	296977.1	141376.7	25723	-1.9	8
2000	4460				1.1	8

Table 2: Brazil

Date	Military spending (b1995 Reais)	GDP (m1995 Reais)	Debt ($m1995)	Debt Service ($m1995)	Inflation (%)	Democracy (Dem-Aut from Polity 98)
1970		206788.3	21070.63		17	-9
1971	5.46	230145.2	25884.74	2793.356	20	-9
1972	5.08	257884.2	38283.94	3665.671	19	-9
1973	4.9	293933	45868.44	5532.725	23	-9
1974	4.13	320510.8	63493.08	9136.485	35	-4
1975	3.68	337206.5	72087.99	10665.17	34	-4
1976	3.94	370220.3	82551.23	9915.635	48	-4
1977	4.12	387273.9	97392.07	12440.85	46	-4
1978	4.06	399789.4	117489.1	16953.08	41	-4
1979	3.22	426840.3	121275.9	20935.92	56	-4
1980	3.26	465729.6	129148.8	24944.14	87	-4
1981	3.16	445268.4	133305.1	27383.3	107	-4
1982	4.17	447852.1	144909	27748.86	105	-3
1983	3.91	432581.2	145478.5	18388.88	140	-3
1984	4.11	455374.5	146593.2	18113.15	213	-3
1985	4.42	491558	141268.5	14639.5	232	7
1986	5.48	530825.1	145108.8	14472.32	145	7
1987	5.81	549932.8	154363.5	14417.97	204	8
1988	8.21	549368.2	145646.5	19561.22	651	8
1989	8.51	567384.5	136150.8	15711	1323	8
1990	5.84	542987	136549.4	8709.857	2509	8
1991	3.45	550045.8	132618.9	8558.376	415	8
1992	5.14	547295.6	137536.4	8666.1	969	8
1993	6.79	574113	149599.2	10945.19	1997	8
1994	6.82	607985.7	153833.6	15439.01	2239	8
1995	10	633521.1	159072.9	20294.58	78	8
1996	8.63	651259.7	179072.1	23212.14	17	8
1997	10.6	672100	195502	38843.41	7.8	8
1998	9.98	673108.2	238669.1	43696.6	3.6	8
1999	9.2	679839.3	233913	67522	4.3	8
2000					7.1	8

Table 3: Chile

Date	Military spending (m1995 Escudo)	GDP (m1995 Escudo)	Debt ($m1995)	Debt Service ($m1995)	Inflation (%)	Democracy (Dem-Aut from Polity 98)
1970	196415	8091774	10939.31		41	6
1971	255217	8821487	10603.92	1392.281	18	6
1972	287075	8749223	11768.32	557.9413	86	6
1973	286225	8316914	12053.59	691.9565	414	-7
1974	634572	8524325	15104.02	1121.329	665	-7
1975	490789	7555725	14556.66	1571.813	334	-7
1976	421149	7813102	13914.94	2273.212	251	-7
1977	591485	8492642	13630.54	2624.103	106	-7
1978	780729	9126442	15877.76	3221.268	58	-7
1979	833224	9918828	18511.82	3866.018	46	-7
1980	796242	10727075	21816.04	4573.283	29	-7
1981	862406	11235249	25636.55	5571.063	13	-7
1982	944585	10075409	26713.17	5308.831	8.5	-7
1983	775800	9693896	26473.96	3637.055	31	-6
1984	783255	10466823	27858.63	3667.605	13	-6
1985	845174	11211980	27794.31	2899.08	31	-6
1986	895407	11839442	28142.5	2765.271	22	-6
1987	901391	12620160	27684.79	2854.748	25	-6
1988	859853	13542846	24296.28	2494.019	21	-1
1989	895426	14973015	21431.39	2967.916	12	-1
1990	819103	15526655	21899.78	2955.282	21	8
1991	826852	16764126	19682.63	2771.35	21	8
1992	827825	18822414	20440.88	2693.4	12	8
1993	810622	20137402	21463.76	2766.647	11	8
1994	849375	21286869	25157.6	2818.779	13	8
1995	860000	23549147	25562.2	4805.205	9.3	8
1996	911204	25294962	27096.56	5684.469	2.7	8
1997	915135	27210974	30960.12	4071.613	5.3	8
1998	1059158	28139049	35406.65	4088.512	5.1	8
1999	929390	27857681	36101.34	5209	3.5	8
2000					4.1	8

Table 4: Peru military spending

Date	Peru Military spending (m1995 Nueva Sol)
1970	7.46
1971	6.72
1972	7.69
1973	9.48
1974	9.47
1975	8.45
1976	9.66
1977	14.1
1978	11.2
1979	7.86
1980	11.1
1981	9.58
1982	12.1
1983	9.69
1984	7.12
1985	8.53
1986	7.67
1987	8.26
1988	4.14
1989	2.87
1990	2.42
1991	1.86
1992	2.17
1993	1.99
1994	1.99
1995	1.87
1996	1.95
1997	2.07
1998	2.27
1999	2.27

Table 5: Miscellaneous variables used in Chapter 6

Year	ACCON	ALFONSIN	MENEM	PERON
1970	2	0	0	0
1971	2	0	0	0
1972	1	0	0	0
1973	1	0	0	1
1974	1	0	0	1
1975	1	0	0	1
1976	1	0	0	0
1977	1	0	0	0
1978	2	0	0	0
1979	3	0	0	0
1980	2	0	0	0
1981	2	0	0	0
1982	2	0	0	0
1983	2	0	0	0
1984	1	1	0	0
1985	1	1	0	0
1986	1	1	0	0
1987	1	1	0	0
1988	1	1	0	0
1989	1	1	0	0
1990	1	0	1	0
1991	1	0	1	0
1992	1	0	1	0
1993	1	0	1	0
1994	0	0	1	0
1995	0	0	1	0
1996	0	0	1	0
1997	0	0	1	0
1998	0	0	1	0
1999	0	0	1	0
2000	0	0	1	0

The ACCON variable was based on the classification of the Argentina-Chile dispute given in the KOSIMO database of violent and non-violent conflicts (see Appendix 2), with a score of 3 representing 'violent crisis', 2 for 'non-violent crisis', 1 for 'latent conflict', 0 where no conflict is recorded. The variables ALFONSIN, MENEM and PERON are set to one when the President of that name was in power in Argentina for al or most of the year in question. Exception: President Menem had left office by 2000, but rather than create a new dummy for this year, it was treated as part of the Menem 'era', as the author considered that civil-military relations did not change significantly with this change of regime, whereas the move at the start of the Menem Presidency to pardon military officers imprisoned for human rights offences was considered to represent a fundamental break.

Appendix 5: A co-integrating VAR approach to Argentina and Chile

The results of Chapter 6 gave only limited support to the idea of an arms race between Argentina and Chile. While the lag of Chilean military spending was clearly positive and significant in determining Argentine military spending, an influence in the other direction could only be detected if the second lag of Argentine military spending was included. An alternative way to approach this question, rather than through the two separate single-equation models used in Chapter 6, is through a co-integrating VAR framework, using the Johansen approach to co-integration. While this leaves out many of the other relevant variables, it does allow one to look directly for Richardsonian interactions between the two countries. This is the approach taken by Nikolaidou, Dunne & Smith (1999) for example to the Greece-Turkey and India-Pakistan situations, with mixed results. It has also been applied by Kollias & Makrydakis (1997) to Greece and Turkey.

The Johansen approach to co-integration (Johansen, 1987), is based on a Vector Auto Regression (VAR), of a vector of variables, all assumed to be endogenous, on lags of that vector. For a co-integrating VAR, all the variables in the VAR must be integrated of the same order. The Stochastic Matrix resulting from the vector auto-regression is then analysed for long-term (co-integrating) relationships between the variables. The existence of a co-integrating vector indicates a long-term 'equilibrium' relationship towards which the system will over time be expected to move. If one or more cointegrating vectors are found, single equations (the error-correction equations) are then estimated for the change in each of the variables, regressed on lagged changes of all the variables, and on the first lag of the "error-correction" term, i.e. the co-integrating vector. A significant coefficient on the co-integrating vector, if of the appropriate sign, indicates that the variable in question tends to move in a direction so as to restore equilibrium. These equations represent the short-run adjustment processes, while the co-integrating vector gives the long-run relationship. As discussed in chapter 2, this very naturally operationalises the Richardsonian arms race model, but allows for both short and long-term dynamics.

Here we describe a co-integrating VAR estimation for Argentine and Chilean military spending and GDP. First we describe the tests to establish co-integration and find the co-integrating vector. Secondly, we present the results of the short-run error-correction estimations for the variables based on this co-integrating vector. Thirdly we investigate the stability of the system by looking at the effects of shocks to the co-integrating vector and to individual variables.

Four variables were included in the vector autoregression, namely the military spending and GDP of each country. GDP was included to make explicit the budget constraint, which as discussed in chapter 2, is a natural extension of the Richardson model.[141] There are many possible exogenous variables, but one that is clearly needed is the D74 dummy, due to the very large spike in Chilean military spending that year.

First of all, Augmented Dickey-Fuller (ADF) regressions were carried out on the four series to test for order of integration. Argentine military spending and both countries' GDP were clearly found to be I(1). Chilean military spending at first appeared to be I(0). However if the ADF regressions are run with the additional dummy variable for 1974, the unit root hypothesis is clearly accepted. It therefore seems reasonable to proceed with the co-integrating VAR, including the D74 dummy.

An unrestricted VAR (including an intercept and trend) was estimated, which clearly indicated a second-order VAR as optimal. For the co-integrating VAR, the option of

[141] The model using the two log military spending variables was also tried. This indicated a VAR(1), with a single co-integrating vector, indicating a long-term positive relationship between Argentine and Chilean military spending, with elasticity not significantly different from one. The error-correction term was highly

unrestricted intercept and unrestricted trends was selected, due to the fact that in the regressions in chapter 6, a trend was found to be significant for Chile but not for Argentina. The restricted trend option only allows the trend to appear in the cointegrating vector, thus applying to all variables. The unrestricted trend is included as a variable in the short-term equations for the change in each variable, and can therefore be significant in some equations but not in others.

The tests on the maximal eigenvalues and on the trace of the stochastic matrix both indicated one co-integrating vector, though the Aikaike Information Criterion and Schwarz-Bayesian Criterion indicated more. One co-integrating vector was selected. This was:

$$CV = -1.62*M_A + 1.67*M_C + .52*Y_A + .87*Y_C$$

Where M and Y represent the logs of military spending and GDP respectively, with the subscripts A and C representing Argentina and Chile. This gives an almost unitary long-run elasticity between Argentine and Chilean military spending, and has the 'right' relationship between Argentine military spending and GDP, that is opposite signs in the co-integrating vector. However the like signs on Chilean military spending and GDP are counter-intuitive – though this would fit with the single equation estimation for Chile which showed no relationship between Chilean military spending and GDP.

We now turn to the short-run error-correction equations. Table 1 below gives the regression results for the change in Argentine and Chilean military spending. (The equations run from 1972 to 1999). CV is the co-integrating vector. The results for Argentina are not great with a fairly low adjusted R^2, and no significant short-run effects.

significant and of the right sign in both error-correction equations, and the system showed extremely rapid

Chile gives a somewhat better fit, though that may be in part due to the presence of the 1974 dummy. What is important is that in both cases the lagged co-integrating vector is significant, at least at the 10% level, and has the right sign; that is, implying a tendency to restore the equilibrium where the CV is equal to zero. That is, these results support the hypothesis of an arms race between the two countries, in that each has some tendency to adjust towards an equilibrium between their respective military spending levels. The equation for Chile shows a positive and significant trend, as for the single equation results, but also a very highly significant and positive coefficient on the lagged change in Chilean GDP – suggesting that there is at least a short-run response of military spending to national income, in contrast to the results of the single equation model. There is a negative trend for Argentina, which was insignificant in the single equation models – this may in part be due to the absence of the regime variables, debt variables, etc. The short-run equations for GDP are not presented here; the equation for change in Argentine GDP showed no significant variables and a negative adjusted R^2. The equation for change in Chilean GDP had some explanatory power, with a positive and significant (at the 10% level) trend, and a negative and significant (10% level) coefficient on the lagged CV. This would appear to indicate a negative log-run impact of Chilean military spending on GDP, but given the absence of variables such as investment from the equation, it would be unwise to place to much store by this.

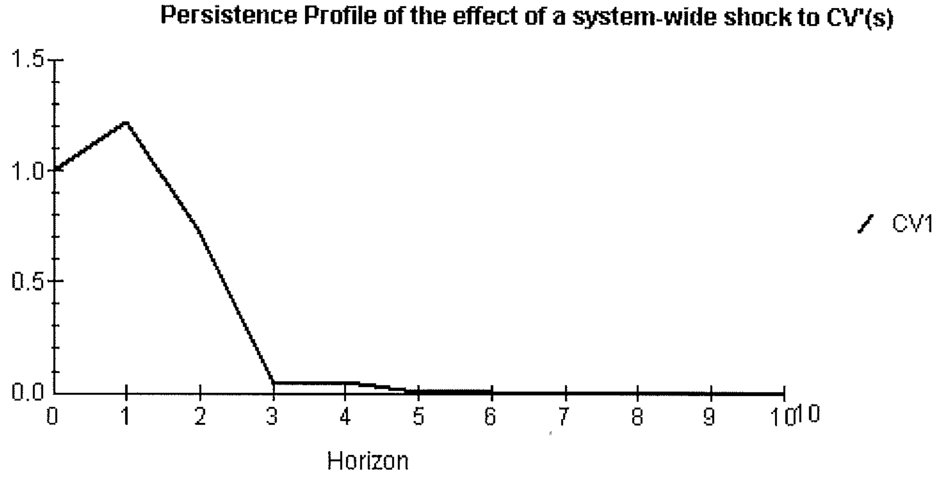
convergence. There were some problems in the diagnostic tests of the two error-correction equations.

Table 1: Short-run error-correction equations for change in Argentine and Chilean military spending

	Dependent variable			
	Δlog Argentine military spending		Δlog Chilean military spending	
Regressor	Coefficient	t-ratio	Coefficient	t-ratio
Intercept	-3.1*	-1.8	3.4**	2.3
Trend	-0.032*	-1.8	0.028*	1.8
$\Delta M_{A,\,t-1}$	0.18	1.0	0.042	0.2
$\Delta M_{C,\,t-1}$	0.070	0.4	-0.053	-0.3
$\Delta Y_{A,\,t-1}$	0.30	0.7	0.19	0.5
$\Delta Y_{C,\,t-1}$	-0.73	-1.6	1.23***	3.0
CV_{t-1}	0.31*	1.8	-0.34**	-2.2
1974	-0.037	-0.3	0.81***	7.8
Adjusted R^2	0.32		0.76	

We now investigate the stability of the system. The MICROFIT econometrics package is able to simulate the effect of a system-wide shock to the co-integrating vector over a given horizon. Figure 1 below plots the value of the co-integrating vector over time, as a proportion of the initial 'shock'. A zero value of the CV indicates the restoration of equilibrium. The graph shows a restoration of equilibrium within three years.

Figure 1



A clearer picture of the long-run relationships can be obtained by looking at the impulse responses to single standard-error shocks (from the error correction equations) in the variables. First we apply a shock to the log of Argentine military spending. Figure 2 below plots the variables over time following the shock[142]. This again shows a speedy convergence, with Chilean military spending increasing almost proportionately to Argentine military spending. The effect on GDP is negligible. It is interesting to note that the shock is almost completely self-sustaining – because of the arms race, neither side's military spending reverts back to its original level. The response to a shock to Chilean military spending, shown in figure 3 is very similar.

[142] In the graphs, LAMILTS is log Argentine military spending, LCMIL2 is log Chilean military spending, LAGDP is log Argentine GDP, and LCGDP2 is log Chilean GDP.

Figure 2

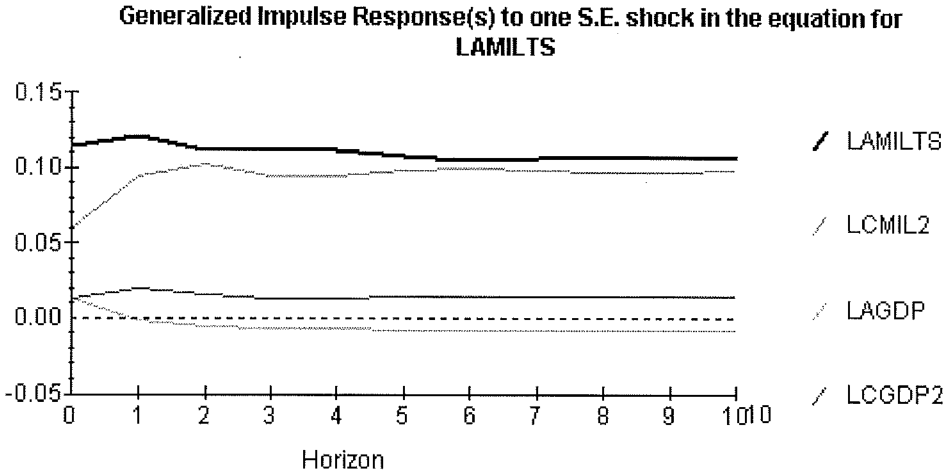


Figure 3

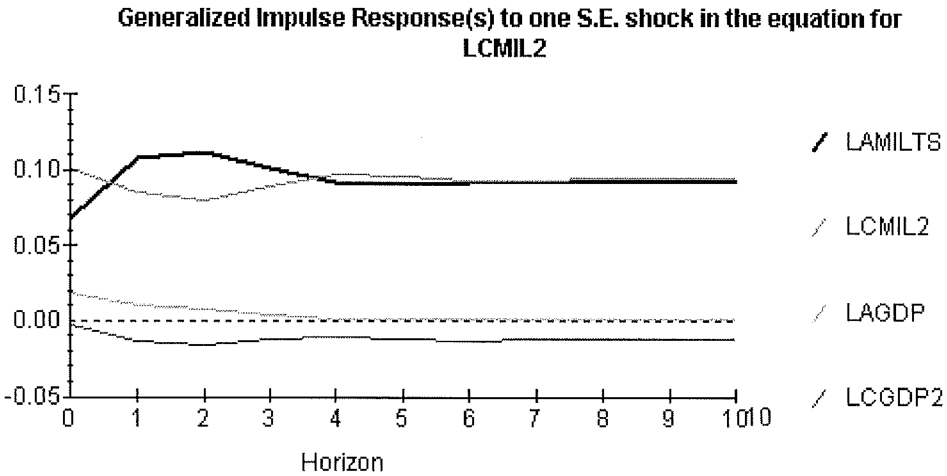


Figure 4 shows the effects of a shock to Argentine GDP. This takes slightly longer to stabilise, namely four years instead of three. Argentine military spending rises almost exactly in proportion to GDP. Chilean military spending rises rather less – this may be because Chile is responding in part to Argentina's military *burden* rather than just the level, or it may be due to the curious relationship with GDP. The rise in Chilean GDP, if this result is treated as meaningful, may be down to a rise in regional trade/the regional economy generally. Finally we shock Chilean GDP, possibly the most likely to produce counter-intuitive results due to the 'wrong' signs in the cointegrating vector. The results are shown in figure 5. As expected, Chilean military spending makes a sharp rise after one year, due to the short-term effects detected in the error correction equation, but then falls back. Argentine military spending rises partly in response to the rise in Chilean military spending, partly due to an increase in Argentine GDP, which again may be down to regional effects – though it is hard to believe that they would be so pronounced. In turn, the higher level of Argentine military spending keeps Chilean military spending above its original level, despite the heterodox military spending-GDP relationship.

Figure 4

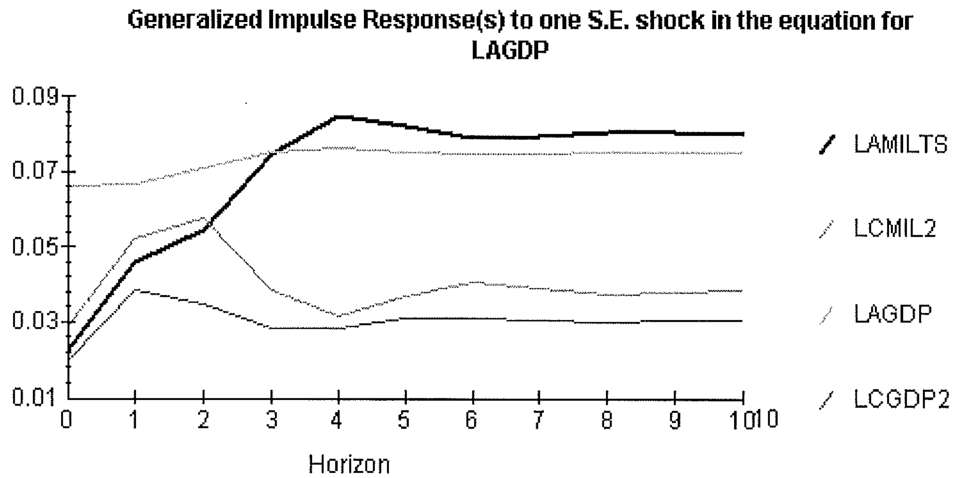
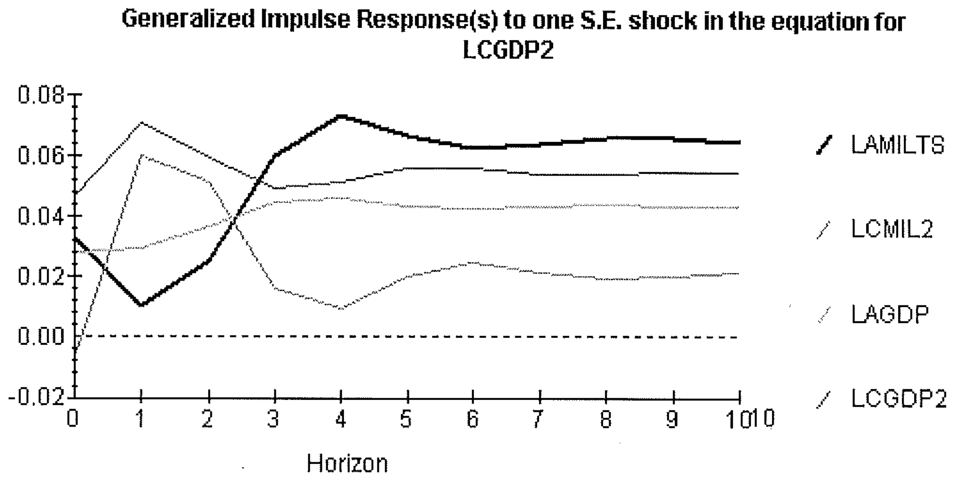


Figure 5



Overall, these results seem consistent with the hypothesis of a long-term arms race between Argentina and Chile, with an exogenous shock to the military spending of either country causing a proportionate response in the other. The curious behaviour of the system in terms of Chilean military spending and GDP, however, must lead us to treat these results with some caution. But taken with the single estimation results, the evidence that the Argentina-Chile relationship is a significant determinant on the military spending of both seems quite strong. This approach leaves out many of the other relevant factors in the single equation estimations, such as democracy, debt and inflation, but gives a useful additional perspective on the two-country inter-relationship.

Appendix 6: The demand for armaments

Chapters 3-6 have analysed the demand for military expenditure in developing countries. Analysing military expenditure is important both as a proxy for demand for armaments or military capability, and in itself as a political/economic phenomenon. However if we are interested specifically in the international arms market, and wish to study the demand side of that market, then military expenditure is not a very close proxy, for reasons discussed in chapter 1. Therefore in this chapter we turn our attention specifically to the demand for arms imports. Section A6.1 discusses theoretical and data-related issues in analysing the demand for armaments. Section A6.2 carries out cross-section estimations of the demand for arms imports along the lines of those for military spending in Chapter 3, while Section A6.3 analyses the demand for arms in the case-study countries of Argentina, Brazil and Chile, and also Peru. Section A6.4 concludes.

A6.1. Analysing the demand for arms

First however we discuss the theoretical and practical problems associated with modelling and estimating the demand for arms. The data problems encountered in analysing military expenditure are considerably worse for arms imports and exports. Many arms deals involving developing countries are not declared, and even if they are made public, the price very often isn't. Prices may also be skewed by countertrade and offset deals, 'friendship' prices, bribery and other distorting factors.[143] Indeed, the US and USSR have frequently given away weapons to their allies, and the US still gives large-scale military aid to countries such as Israel, Turkey and Colombia (e.g. Chomsky, 2002). For this reason, the SIPRI data for arms imports and exports, used here, is not a monetary series, but a 'trend indicator'which attempts to assess an 'objective' value for weapons systems

[143] E.g. SIPRI website, http://projects.sipri.se/armstrade/atmethods.html

based on their age, capability, etc. The construction of the SIPRI trend indicator is described at http://projects.sipri.se/armstrade/atmethods.html. Though this may be the best data available, it does not claim to be more than a loose estimate of the value of weapons systems. The SIPRI series also includes only major weapons and weapons systems, excluding categories such as small arms, where deals are even harder to track.

Arms imports data, even if it were accurate, would still present the problem of being 'lumpy', with major weapons systems deliveries[144] giving particularly high figures in certain years. This complicates the dynamics of any econometric model. Nonetheless we must work with the data available, though it may well be difficult to obtain meaningful and significant results due to the problems described above. We move on to discuss how the demand for arms can be modelled, in comparison with the demand for military spending.

In many ways the demand for arms can be expected to be closely related to the demand for military expenditure. From a **utility** maximisation point of view, both relate to the desire to purchase 'security' through military capability, and both can therefore be expected to depend on overall economic resources as measured by national income, and by the level of threat to which security expenditure is a response.

However there are a number of reasons why demand for arms could potentially differ systematically from demand for military expenditure, and additional reasons why the specific data series used may again give differing results – in other words why the determinants of arms demand may appear different from the determinants of military spending.

[144] In keeping with its focus on the notional military value of weapons systems rather than monetary cost, SIPRI data measures deliveries in each year, rather than payment which may be spread over many years, or indeed may never actually happen.

First of all, in looking at the demand for arms imports, we are leaving out domestically procured arms – this is unavoidable, as it is impossible to obtain data for domestic arms production for the great majority of developing countries. In any case, we may be interested in the international arms trade as such, and thus arms imports rather than total arms procurement. However the effect on the determinants of demand cannot be ignored; those countries in our sample, such as Israel, China, Brazil and India with significant domestic arms production may have lower demand for imported arms. This must be accounted for in our empirical analysis.

Secondly, the importance of major weapons systems (which the SIPRI data measures) within military expenditure as a whole may depend on the role and orientation of the military. An external role, with a focus on preparedness for fighting a conventional war with neighbours, requires a much more major equipment-intensive investment than does an orientation towards internal security, where much cheaper counter-insurgency equipment will be the biggest purchases likely to be needed. Internal conflict may well require a large, well-trained and well-paid personnel, but this is only relevant for military spending demand.

Thirdly, modern major weapons may in some ways be seen as a 'luxury' good within military expenditure; the basic personnel expenditure and general maintenance are 'essentials'. This may be especially true in our South American case studies, where personnel expenditure tends to be a very high proportion of total military spending. Thus one might expect arms imports to rise more sharply than military spending when it rises, and fall more rapidly when it falls.[145]

Fourthly, a country's demographics and geography may affect the mix of personnel and different types of arms used to obtain a given level of military capability. For example a country with a high population may rely more on manpower, whereas a small country may be inclined to go for superiority in hi-tech weaponry.

The effects of economic variables may also be different for arms imports than for military spending, especially given the nature of the SIPRI data series used. On the one hand, arms purchases are much more dependant on foreign exchange, and so may be more affected by debt problems. On the other hand, the price distortions resulting from countries' relationships with superpowers, including in many cases free weapons for close superpower allies such as Israel and Cuba, may partially insulate some countries from the usual economic constraints. Weapons given as military aid will show up as their full value in the SIPRI series, even though they may have incurred no economic cost.

Another economic distortion relates specifically to Latin America, where arms purchases are frequently made on off-budget accounts. This is particularly the case for Chile, where 10% of copper sales automatically go towards arms procurement (see chapter 5), but there are also sources of income from military-owned industries (something which can also apply to countries in other parts of the world.) Chile also borrows ahead on the copper fund. (Scheetz, 1996). As was also discussed in chapter 5, Argentina up to 1982 also extensively used off-budget accounts for military purchases. There are two consequences of this: firstly, arms purchases may not properly show up in military spending figures (a data problem), secondly, arms purchases may be insulated from the sorts of budget constraints that affect military spending (a substantive difference).

[145] This certainly seems to have been the case in Argentina, where at the same time as military spending fell dramatically under Alfonsin, the equipment share of the budget also dropped.

Thus it is quite possible that we will find substantially different demand functions for arms imports than we did for military spending. In particular we will need to take account of certain countries' status as arms producers and as major superpower allies.

A6.2. Cross-country estimations

In this section, we adapt the military expenditure model used in chapter 3 to estimate the demand for arms imports across countries, in the same Cold War and Post Cold War periods. We continue to use the 'Security Web' model, whereby demand for arms is presumed to be a function of total arms imports by neighbours and rivals. Other factors such as war, GNP, population etc. that were used in chapter 3 are also included, as well as some variables relating to the specific issues for arms imports discussed above. The differences between the model used here and that of chapter 3 are described below.

We start by looking at the Security Web variables. The same coding of countries as belonging to the Security Web of another country or being Potential Enemies is used. The Enemies category is now simply included in Potential Enemies, and not treated separately, as it was never separately significant in the military spending case. China is included in the Security Web of all countries previously coded with the China proximity dummy.

The variables used are average arms imports of countries in the Security Web and of Potential Enemies. To make some allowance for the effect of previous build-up of military capability, figures for arms imports for a security web country are averaged over the 12-year period starting 4 years before the period in question (1981-88 or 1990-97). For countries that are classified as Potential Enemies over only part of the period, the data is averaged from 4 years before the start of the enmity to either the end of the enmity or of the period. This is then multiplied by the number of years for which they are classified Potential Enemies divided by 8, to obtain a pro-rata figure.

For a country to be included in the sample, five out of eight observations for arms imports were required. For a country to be included in the Security Web of their neighbours, four observations were required, three if they have a very small total. No Unquantified Threat variable was calculated, as this proved completely insignificant in the military spending case.

As discussed above, a country's demand for imported arms may depend on their ability to procure them domestically. This is measured in two different ways: firstly using the SIPRI measure for arms exports, totalled over the period. Secondly, as this figure may not reflect domestic arms procurement, may be inaccurate, and may also include resold arms rather than domestically produced arms, a dummy variable, PRODUCER, was used for the major third world arms producers: Israel, China, Brazil, India, South Africa, North Korea and South Korea.

We also seek to take account of the privileged access to cheap or free arms available to major allies of the US and the USSR (the latter only during the Cold War period.) A dummy variable, ALLY is therefore included for the following: Cuba, Egypt, Israel, North Korea, South Korea, Taiwan and Turkey.

The following variables from chapter 3 are also used as they stand in these models: GNP, Population, External War, Civil War, Great Power Enemy, China proximity, Middle East, USA proximity, USSR proximity, Democracy. A log-linear model is estimated for each period, with the dependant variable being log of SIPRI arms imports[146]. Income, population, arms exports and the Security Web variables are also log transformed.

A6.2.1 Results: Cold War

Of the 93 countries in the original sample used in chapter 3, sufficient data was available for 81. (It is predominantly sub-Saharan African countries left out.) Table 1 below gives the results of the full regression, and a reduced form with insignificant variables deleted. The full model showed most variables insignificant. A variable deletion test was performed for those variables with t-ratios less than one in absolute value (population, external and civil war, Security Web military spending, ALLY, democracy and the USSR dummy). This was easily accepted. This did not affect the individual significance of any variables. A joint variable deletion test for CHINA, US and log arms exports showed the variables to be jointly significant at the 10% level. These three are therefore left in the final model, though they are clearly of at best marginal significance. The R-bar squared of 0.69 is not too bad, but the standard error of 1 means the model is poor for predicting individual cases.

[146] This is not expressed as a proportion of GNP; to do so would not be very meaningful, as the SIPRI indicator is not a monetary measure.

Table 1

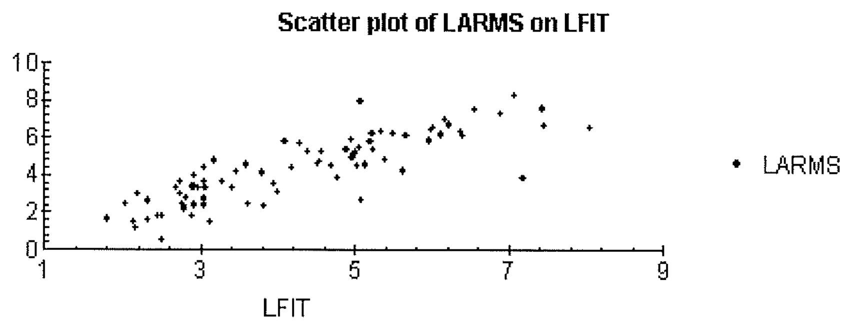
	Model 1		Model 2	
Regressor	Coefficient	t-ratio	Coefficient	t-ratio
Constant	*-2.22	-2.0	**-2.00	-2.5
log GNP	***0.61	4.7	***0.57	6.4
log population	-0.08	-0.6		
External War	0.24	0.4		
Civil War	0.099	1.1		
log Security Web arms	0.011	0.1		
log Potential Enemies arms	***0.17	3.2	***0.19	4.2
ALLY	0.41	0.8		
PRODUCER	**-1.43	-2.3	**-1.37	-2.4
log arms exports	0.093	1.0	0.11	1.4
Great Power Enemy	*0.92	1.7	**0.99	2.4
Democracy	0.01	0.4		
CHINA	0.53	1.3	0.52	1.4
Middle East	*0.92	1.9	**0.94	2.6
US	-0.55	-1.3	-0.41	-1.1
USSR	-0.35	-0.5		
Adjusted R^2	.674		.694	
Standard Error	1.04		1.00	

It is somewhat surprising that the war variables proved completely insignificant in this case. We also have no evidence that arms purchases by neighbouring, non-hostile powers, has any influence on a country's arms imports. This remains the case if the nested specification is replaced by a separate categories specification, with log of "Others" arms (i.e. Security Web but not Potential Enemies) used instead of log Security Web arms. However the effect of arms purchases by hostile neighbours is very strong.

There is a problem with the functional form diagnostic for this regression, Ramsey's RESET test using the square of the fitted values, which is significant at the 1% level. This is not cured by using a levels rather than a logs specification, indeed this gives a far worse set of results. There is also an apparent problem with the normality of the residuals, from the Jacques-Bera test, though the histogram of the residuals shows an extremely good normal distribution. The White test for heteroskedasticity is also significant at the 10% level.

An examination of the scatter plot of actual against fitted values in the log regression, shown in Figure 1, gives some insight into the problem.

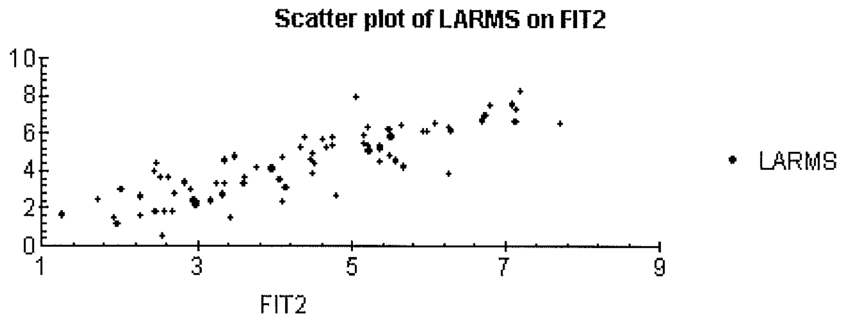
Figure 1



LARMS = log arms imports, LFIT = fitted values from model 2.

This shows some signs of a quadratic relationship, with the curve flattening out at high values. As the (non-dummy) variable with the single biggest impact on the regression is log GNP, the square of this variable was introduced into the regression. This proved negative and significant at the 5% level, and both the functional form and normality problems vanished. The R-bar squared value increased somewhat, to around 0.71. The new scatter plot in Figure 2 confirms that the relationship is now more or less linear.

Figure 2



(LARMS = log arms imports FIT2 = fitted values for regression including square of log GNP.)

The values of the coefficients of log GNP and log GNP squared suggest that for the largest economies in the sample, arms purchases are no longer increasing with income.

However a simpler way of dealing with the problem may be to look at outliers: in particular, China has an extremely low level of arms imports for the period, as recorded by SIPRI. (It is much higher in the 1990-97 period.) They are more self-sufficient in arms than any other Third World nation, though their exports are not that huge (though the largest of the Third World). Thus, the PRODUCER and log arms exports variables may not provide a good fit for China. If China is left out of the regression, the log GNP squared term ceases to be significant, and the functional form problem disappears.

A6.2.2 Post Cold-War

In this case, only sixty-three countries from the original sample had sufficient data. It was mostly sub-Saharan African and Central America & Caribbean countries left out.

In this case, only the final regression is shown, in Table 2 below.

Table 2

Regressor	**Coefficient**	**T-Ratio**
Constant	-2.80***	-3.7381
Log GNP	.55***	7.5060
Log Security Web arms	.15*	1.8124
Log Potential Enemies arms	.10**	2.1249
Log arms exports	.24***	3.5021
Producer dummy	-1.90***	-3.5907
Great Power Enemy	.88*	1.7174
Adjusted R^2	.721	
Standard Error	.881	

This time there are no problems with functional form, heteroskedasticity or normality of residuals. There are some notable differences here: the Middle East and US dummies are insignificant, while the overall level of arms acquisitions in the Security Web is significant, as well as that of Potential Enemies. Thirdly, while there is still a strongly negative coefficient on the PRODUCER dummy for the major Third World producers, there is now a countervailing positive coefficient on the actual level of arms exports. The relative size of the coefficients is such that all but the largest arms producer, China, would still have an overall negative coefficient. Perhaps the interpretation is that only the largest producers can significantly reduce their imports, and that otherwise, arms exports (which may include second-hand rather than domestically produced arms) is a sign of a high level of participation in the international arms market.

In contrast with the Cold War estimation, the square of log income is not significant when added to the regression, and a scatter plot of actual against fitted values does not seem to show a non-linear relationship. China no longer seems to be such a massive outlier, and indeed a dummy variable for China is insignificant. This would seem to suggest that the best explanation for the functional form problem in the Cold War regression is a problem of the one extreme outlier of China, rather than a systematic non-linear relationship.

It is interesting to compare the results of this study with those of the parallel military expenditure estimations in chapter 3. Some factors are the same, most notably the threat factors represented by neighbours' military expenditure/arms purchases, regional factors and Great Power Enemy status (the last more significant for arms.) All of these show as significant in at least one of both the military spending and the arms studies. The one absolute common thread between all four cross-sections is the level of military spending/arms purchases of Potential Enemies. This strongly suggest that the sale of arms to a country involved in disputes with its neighbours is likely to lead to increased arms acquistions by that country's rivals.

Beyond that, there are major differences. On the one hand, the variables relating to arms producer status appear in the arms regressions but not the military spending; this is unremarkable, as the arms imports figures we are using are simply not capturing all of the arms procurement of the major producers. More interesting is the omission of many variables that were significant for military spending from the arms regressions.

Most glaring is the insignificance of the war variables. This is not simply down to lack of variation; the excluded countries from the arms samples are not disproportionately countries involved in war, civil or external, indeed for external war the opposite is true. It is possible that countries at war are more successful at hiding their arms imports, but the same could just as easily be true of military expenditure. It seems almost inconceivable that countries involved in especially external war would not spend more on arms, even given the same level of spending by their enemies, but somehow the data is not picking this up. It follows that any other conclusions that may be drawn from the insignificance of variables must be heavily qualified, as these may also be due to the failure of data to pick up effects. This applies to the subsequent paragraphs.

There is a difference in behaviour with regard to national income. Military spending was shown earlier in this chapter to be very close to proportional to GDP across countries, but the above results show the income elasticity of demand for arms imports to be significantly less than unity. If this is meaningful, it suggests that among developing countries, greater economic resources are channelled more towards better pay, training and general equipment for soldiers than towards bigger and fancier weapons systems.[147]

The highly significant and negative coefficient on population observable for military burden is also absent for arms purchases. Does this mean that extra population, other things including GDP constant, reduces personnel expenditure? That would seem bizarre. But there is another way of looking at this negative coefficient: that as population rises, holding GDP per capita constant, military spending rises less fast than population and income. This would fit in with a country not needing to expand its armed forces in proportion to population, i.e. the force ratio will fall.

[147] This may not simply be a factor of data problems; an alternative regression of log arms on log military spending and other variables shows that in the cold war case, log income is significant and negative – that is, the higher the income, the less arms imports are compared to military spending.

Democracy is also not significant for arms imports. This could be because SIPRI arms imports, consisting of major weapons systems, relate more to external defence than internal security or suppression of dissent. Thus, dictatorships may tend to spend more on a large and well-paid and equipped army to keep them loyal and the population down, but not especially on major weapons for external defence. However as noted, not too much can be drawn from the insignificance of population and democracy – the apparent difference from the military spending regressions may simply be a data issue.

A6.3 The South American case studies

Having investigated the determinants of arms imports across countries, we now turn to the demand for arms in our case studies of chapters 5 and 6, Argentina, Brazil and Chile. As data was gathered for Peru as a Potential Enemy of Chile, Peru is also analysed. Section A3.1 examines the SIPRI data series for major arms imports for the period 1970-2000 for these countries. The results of attempts at time-series estimations of arms imports are described in section A3.2. These carry the problem of the complicated dynamics of arms imports: the 'lumpiness' of the series due to intermittent purchases of major weapons systems. An alternative approach, pooling the data for the four countries, is described in section A3.3. Finally, section A3.4 looks at the relationship between levels of arms imports and those of military spending.

A6.3.1 Arms imports data for Argentina, Brazil, Chile and Peru

Figure 3 below displays the SIPRI trend indicator for arms imports for the four countries from 1970-1999, while figure 4 shows 5-year moving averages of the series, to smooth out the 'lumps' in the data. We see

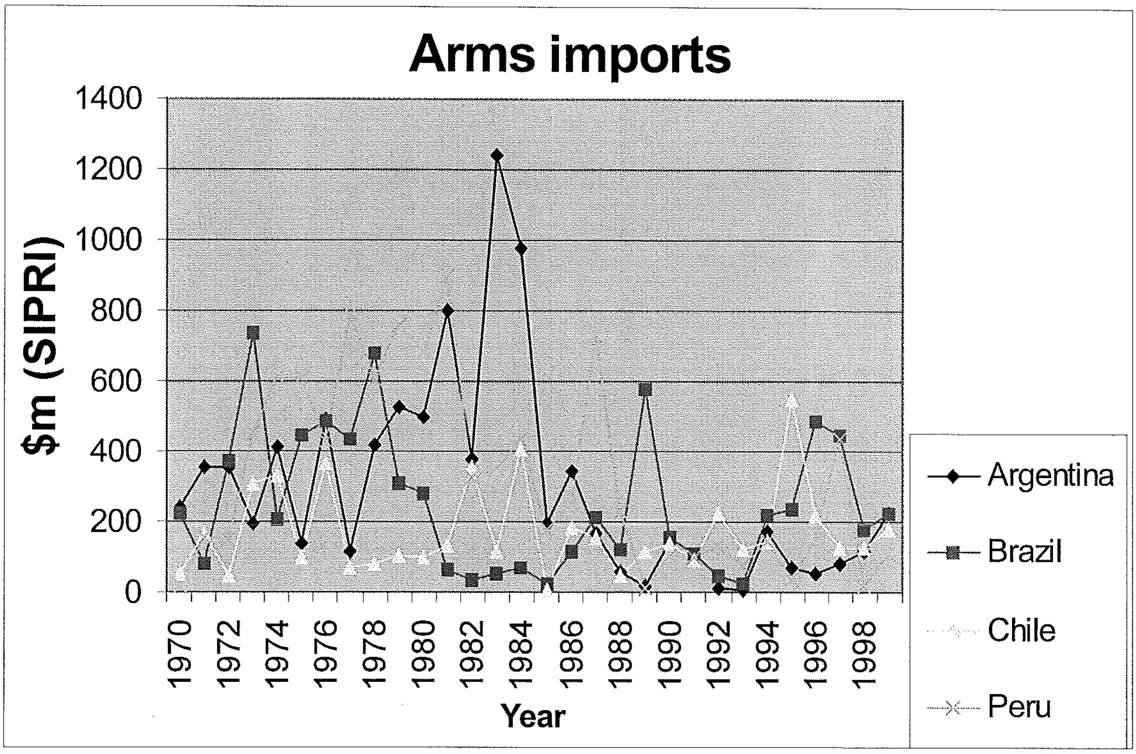
Argentine arms imports experiencing a number of peaks in the 70s, with persistently high values from 1978-81, the period of greatest tension with Chile. Acquisitions soared in 1983-84, when Argentina was rearming after the Falklands War. (Deliveries in 1984 would mostly have been ordered under the previous military government.) Thereafter the figure falls massively and remains very low throughout the rest of the period, with the advent of democracy, lessening of tensions with Chile, and persistent debt problems.

Brazilian imports were high through most of the seventies, then fell to very low levels in the eighties and early nineties, with the exception of a large peak in 1989. After 1983, acquisitions recovered significantly as the armed forces modernised and programs such as SIVAM got under way.

Looking at the moving average series for Chile, we see that Chilean arms imports seem to be fairly cyclical. Peaks occurred in 1973, 74, 76, 82, 84 and 95, though there were a number of smaller peaks in the late eighties and early nineties.

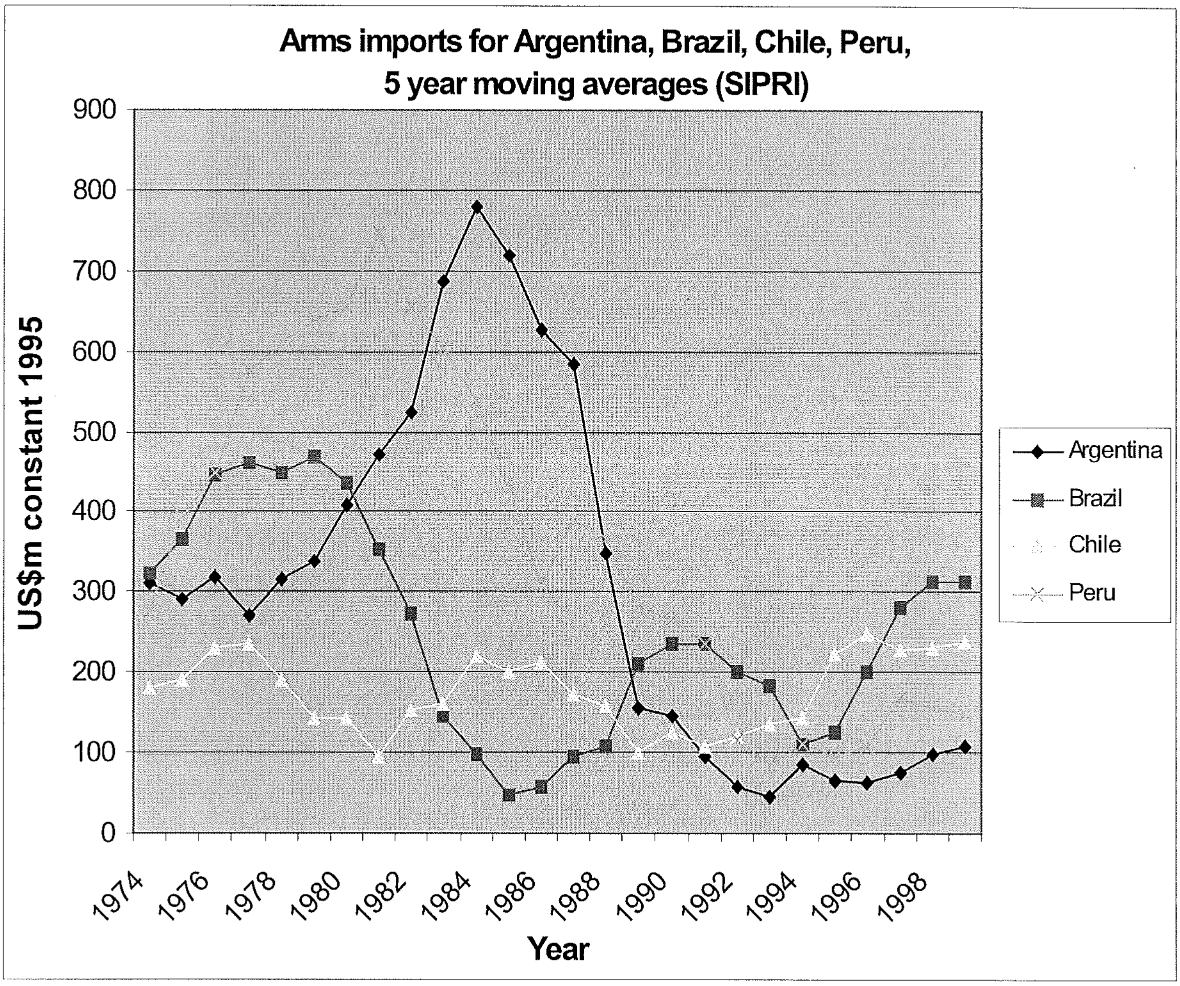
The moving average series shows Peru's imports following a similar pattern to Argentina's, though somewhat ahead. Imports were high in the seventies and early eighties, thereafter falling to much lower levels.

Figure 3



Arms imports
$m (SIPRI)
1400
1200
1000
800
600
400
200
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
Year
Argentina
Brazil
Chile
Peru

Figure 4



A6.3.2 Single equation estimations

Standard OLS time-series regressions, using a similar set of variables to those used in chapter 6, proved to be of very little use in this context. Chilean arms imports could not be consistently made to depend on anything. The best regressions for Argentina gave the remarkable information that Argentine arms imports were very high during the post-Falklands re-armament period (1983-84) and much lower thereafter, but otherwise related the series to nothing else. Attempts to predict 'peaks' in the series using logit and probit models were equally unsuccessful. Only in the case of Brazil was it possible to get semimeaningful results. In this case, both Brazilian military spending and various other economic and political factors were included, to gauge differential effects in the demand for arms as compared to the demand for military spending. The moving 4-year total of previous arms imports was also included as a regressor, which worked better than using any other combination of separate lags. The results are shown in table 3.

Table 3: Regression results for log of Brazilian arms imports, 1974-1979

Regressor	Coefficient	T-Ratio
Constant	-10.77	-1.52
log of total of last 4-years imports	***0.60	3.29
log of lagged milex	***2.42	5.59
log GDP growth	***10.65	3.25
log Argentine milex	***2.60	5.11
log lagged debt	***-1.33	-2.87
lagged democracy	***0.13	3.19
Adjusted R^2	.715	
Standard Error	.529	

The results appear to show Brazilian arms imports following Brazilian military expenditure patterns, and following many of the same determinants, such as debt and short-term growth, but with exaggerated effect[148]. Argentine military spending, an external factor, shows a much stronger effect on arms demand than on general military spending, which is natural in that major weapons systems are much more important for dealing with

[148] Log of GDP growth had a positive coefficient in the military spending regressions, but was insignificant.

an external threat. The lag on the democracy variable was used due to the lag time between orders and deliveries. The positive coefficient on this variable, while initially counter-intuitive, may be a measure of the desire to reorient the armed forces towards an external role following the democratic transition. However these results probably merit a certain degree of scepticism as to their meaningfulness, as they were more or less obtained by data mining.

A6.3.3 Pooling the four countries

Given the failure to obtain meaningful results using individual country time series regressions, an alternative approach was tried by taking averages of data over a longer period, and then combining the data from different countries to make a mini-panel. This was done for Argentina, Brazil, Chile and Peru. Averages were taken of all variables over 5-year periods (1970-74, 75-79, 80-84, 85-89, 90-94, 95-99), and an OLS pooled data regression was run on the resulting 24 country-periods.

For external effects, a similar procedure was followed to the cross-country regressions for military spending and arms in chapter 3: variables were constructed for the arms purchases of the Security Web of each country, and of Potential Enemies (including Enemies) within that. The classification of Security Web and Potential Enemies was the same as that used for chapter 3, and thus included other countries than the four under study. In all cases the SIPRI data for arms imports was used.

The variables included were: GDP ($US 1995), Debt, Debt Service, Security Web arms imports, Potential Enemies arms imports, Democracy, arms exports and a dummy for the 1980-84 period for Argentina, which included the Falklands war and subsequent re-armament. As for the individual country regressions, models using debt were compared with those using debt service. In this case, the models with debt were clearly preferable, with much higher R-squared values.

Non-nested tests gave ambiguous results as between a levels or a log specification. Table 4 below shows the results for both models, showing in each case the model with insignificant variables deleted.

Table 4

Dependant Variable:	Arms imports		Log arms imports	
Regressor	Coefficient	T-ratio	Coefficient	T-ratio
Constant	***948	3.22	***9.63	6.31
GDP (log GDP)	**. 00094	2.26	**0.53	2.40
Debt (log Debt)	**-.0034	-2.11	***-0.80	-2.79
Potential Enemies arms imports	*. 32	2.05		
Falklands Dummy	***2679	3.91	***1.41	2.59
Adjusted R^2	.47		.32	
Standard Error	.67		.53	

Diagnostic tests indicate no problems of functional form, heteroskedasticity or non-normality of residuals in either case. Between the two we have clear economic linkages with arms imports, and an ambiguous reaction effect from rivals' purchases.

Attempts to add period or country dummies to the levels regression do not yield significant results, except that a dummy for Chile is significant at the 10% level and, somewhat surprisingly, negative. In the log regression, the coefficient for the 1990-94 period (immediately post cold-war) is highly significant and negative. This may be because the log regression has not included any neighbours' effects.

These regressions give at least some limited evidence that arms acquisition patterns in these four countries, the four largest in South America, are following understandable patterns, though the fit is not very good.

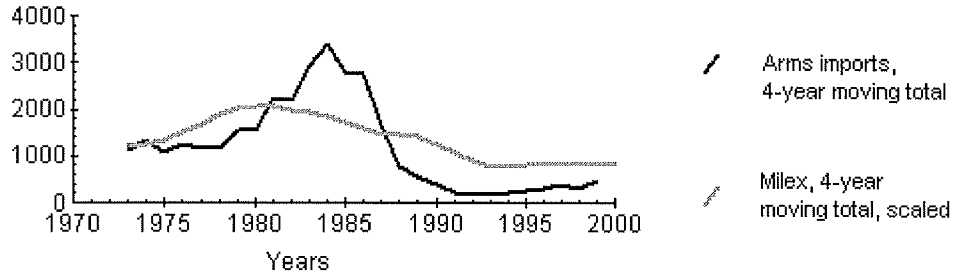
A6.3.4 Arms and military spending

Given that attempts to relate arms imports to likely causal variables has met with limited success, a final approach to the demand for arms is to explore the relationship between military spending and arms more closely in the four countries (including Peru), that is to see if demand for arms can be expressed in simple terms as a function of total military expenditure. To do this 4-year moving totals of both the military spending and arms series were used, to smooth out the 'lumps' in the arms imports series.

Argentina

Figure 4 below shows the smoothed-out graphs for arms and military spending for Argentina. The blue line is the moving total of arms, the green line is a scaled moving total of military spending. The series show a common rising and falling pattern, though the arms peak lags the military spending peak by some years. The two series show a correlation of 0.79, rising to 0.83 if the lag of the military spending series is used, and .845 with the second lag, which is optimal. (The raw correlation between arms and military spending, unsmoothed, is 0.65) The lags are easily understandable in terms of lags in delivery of major weapons.

Figure 4: Arms and Military spending for Argentina



To explore the relationship between the two variables empirically, we look to see if the two series are co-integrated. Co-integration implies that there is a long-run relationship between two or more variables, in this case military spending and arms imports. Equivalently, shocks to the relationship tend to die away over time. This can be tested for using the Johansen co-integrating VAR procedure (Johansen, 1988). This procedure is often used to test for arms races between two countries, that is a long-run relationship between their levels of military expenditure.

Augmented Dickey-Fuller tests show that both military spending and arms imports (levels or logs) are I(1). First of all, a Vector Auto Regression (VAR) is estimated between log of Argentine military spending (LM) and log of Argentine arms imports (LA). That is, each variable is regressed on its own lags and lags of the other. Initially a VAR(2) was estimated, that is going back to the second lag, with a 1991 dummy used as an additional deterministic variable. This is because there is a gap in the SIPRI data series for Argentine arms imports for 1991.[149]

[149] A value of zero was used for this year, which is reasonable as SIPRI does not record any major weapons systems deliveries for Argentina in 1991; however the log specification is subject to distortion here, as one cannot take the log of zero; the variable used was log(Arms imports + 1) where arms imports are measured in $m 1995.

An Adjusted Log Likelihood test (MICROFIT manual) is used to find the optimum order of the VAR. This clearly shows a VAR(1) to be appropriate: the null hypothesis of VAR(0) (i.e. no lags needed) is rejected at the 0.1% level of significance, while the null of VAR(1) is accepted against the alternative of VAR(2) or more.

A co-integrating VAR specification is then attempted, with lag order of one, unrestricted intercepts and no trends, and with the 1991 dummy remaining as an exogenous deterministic variable. Tests based on the maximal eigenvalues and the trace of the stochastic matrix both indicate a single co-integrating vector, rejecting the null hypothesis of no co-integration at the 95% confidence level. The Aikaike Information Criterion, the Schwarz-Bayesian Criterion, and the Hannan-Quinn Criterion also all indicate a single co-integrating vector.

Using the stochastic matrix, the co-integrating vector (CV) is found to be:

$Z_t = -LA_t + 1.91*LM_t$.

Indicating a long-run relationship of LA=1.9LM. The sign of the coefficients is as one would expect, and a greater-than-unitary elasticity of arms imports with respect to military spending is indicated.

Moving to the Error-Correction equations, the change in arms imports (DLA) is regressed on a constant, the lag of the CV and the 1991 dummy. The equation is:

$DLA_t = -7.4\ (1.7) + 0.65*Z_{t-1}\ (0.14) - 4.6*D1991\ (0.93)$ + residual

Where D1991 is the dummy for 1991, and figures in brackets are standard errors. This shows both the error-correction term, Z_{t-1} and the 1991 dummy to be highly significant, at the 0.1% level. The R-squared is 0.66, which is very good for an ECM in a co-integrating VAR, though it is increased by the 1991 dummy. The sign on the CV is correct, indicating a tendency to move back towards the long-run relationship, and the size of the coefficient, 0.65, indicates a very rapid adjustment.

It is interesting to test whether the coefficient of LM in the CV is statistically greater than one – this would confirm the hypothesis that major weapons systems are a 'luxury' good within military spending, as opposed to the 'essentials' of salaries, etc. However imposing the restriction that the coefficient of LM in the CV is equal to one is accepted by a likelihood-ratio test, with $\chi^2(1) = 1.37$.

Thus the hypothesis of unitary elasticity, that is that arms imports are generally proportional to military spending, cannot be rejected.

The Error Correction equation for change in military spending gives much poorer results, which suggest that it is the overall level of the military budget that determines what weapons can be afforded rather than vice-versa.

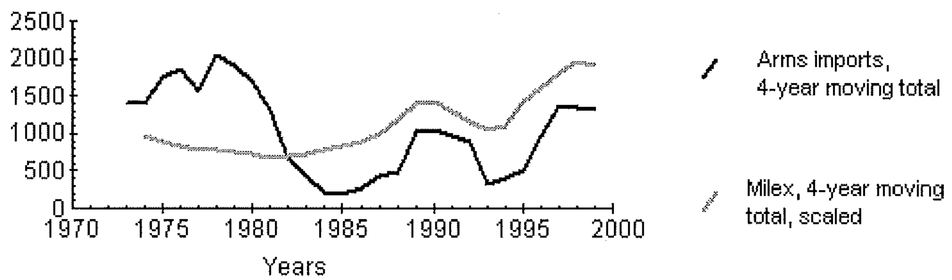
The co-integration procedure can also be performed in levels, giving similar results: a VAR(1) specification, a single co-integrating vector (which suggests that for every $bn dollars of military spending at 1995 prices and exchange rates, there will be around $60m of imports of major weapons systems according to the SIPRI trend indicator.[150]), and a very rapid convergence rate.

Overall these results suggest that the problem of analysing demand for arms imports in Argentina is not fundamentally different from the problem of military spending – acquisitions are erratic and lumpy, but over the medium term follow overall military spending levels very closely.

Brazil

Figure 5 below shows the graphs of the smoothed-out series for arms and military spending for Brazil.

Figure 5: Brazil arms and military spending



These two show a remarkably close pattern from about 1984 onwards (possibly co-incidentally, the point of return to democracy.) Before then, we see a level of arms imports much higher than would seem justified by the level of military spending, in terms of the subsequent patterns.

The correlation between the two smoothed series from 1984 onwards is 0.91.

150 Recall that the SIPRI trend indicator is not a monetary measure, so this statement cannot in any way be read as '6.2 percent of Argentine military spending is spent on imports of major weapons systems.'

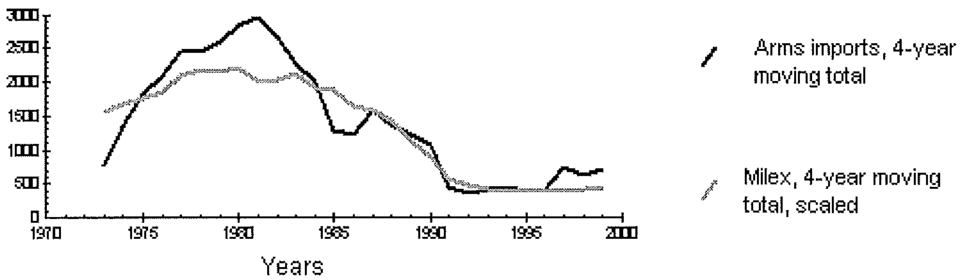
There are various possible explanations, both in terms of data inaccuracy and substantive reasons for the lack of convergence of the series prior to this point:

1) The data series used for military expenditure up to this point may be underestimates.
2) The break corresponds roughly to the democratic transition: up to this point, the military government may have put more effort into finding extra-budgetary sources for arms.
3) The seventies' were a time of high regional tension, when Brazil may have been particularly interested in arms to deter and to acquire regional hegemony, whereas afterwards they were more interested in safeguarding military salaries to prevent revolt, while allowing equipment to deteriorate.
4) In the Cold War Brazil may have been more able to acquire weapons through military aid, which therefore don't show up in the military spending figures.
5) Over time, Brazil has become more self-sufficient in a wide class of armaments. This would explain why arms imports reduced in proportion to military spending. (However, this would not explain why in the later years the two series were very close).
6) Looking at the regression for Brazilian military spending above, we see that, over and above the level of military spending, Brazilian arms imports are influenced by growth (+ve), debt(-ve) and Argentine military spending (+ve). All of these factors changed in a way so as to reduce arms imports through the eighties. (Only the democracy variable, with a positive coefficient for arms imports, moved in the opposite direction.)

Peru

Peruvian arms purchases follow a similar pattern to those of Argentina, and likewise show a close connection with military spending. Figure 6 below again shows 4-year moving totals for arms and military spending.

Figure 6: Peru arms and military spending



In the Peruvian case there is not so much evidence of arms purchases exaggerating the rises and falls of military spending as was the case for Argentina. There does not seem to be a lag between the series, and the correlation coefficient is high at 0.91. In fact even the un-smoothed series have a correlation coefficient of 0.71.

A co-integration approach (as in the case of Argentina) is more problematical, as the series for the log of Peruvian arms imports appears to be stationary. However the levels series is I(1) according to an ADF test if one excludes a trend from the test.

As is the case for Argentina, a VAR(1) specification is indicated, leading to a single co-integrating vector, according to which $1bn of military spending at 1995 prices and exchange rates leads to $125m of imports of major weapons systems according to the

SIPRI trend indicator. The rate of convergence is extremely fast, with a coefficient of 0.82 on the CV in the error correction equation for arms, which has an R-squared of 0.43. As for Argentina, the error correction term is insignificant in the equation for change in military spending.

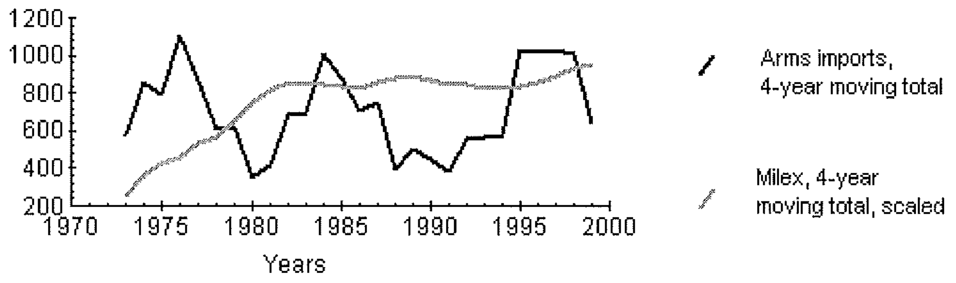
The regression of log Peruvian arms purchases on log military spending shows an elasticity very close to 1 (1.03 with s.e. of 0.24). This regression explains over half the variation in log arms imports (R-squared =0.53), and appears to have no problem of serial correlation (DW=2.3).

As with Argentina, indeed even more so, the demand for arms cannot be easily distinguished from a 'lumpy' version of the demand for military spending.

Chile

Chile perhaps presents the most anomalous case. Figure 7 below shows the 4-year moving total of Chilean arms imports, along with a suitably scaled 4-year moving total of Chilean military spending.

Figure 7: Chile arms and military spending



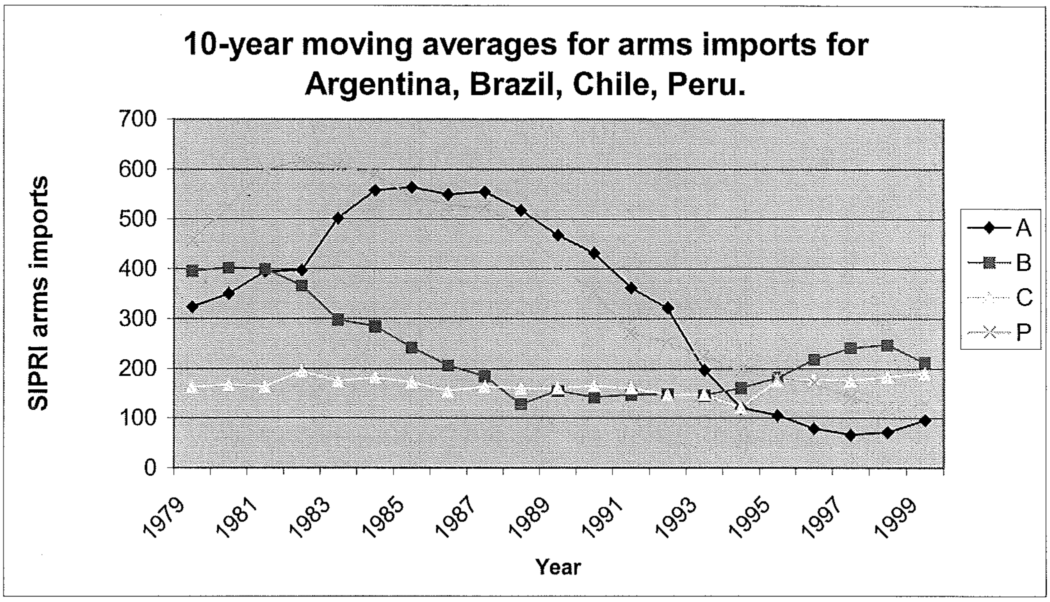
The graphs show no apparent relationship whatsoever between the moving totals of military spending and arms. Correlation analysis confirms this, showing a very slight and statistically insignificant negative correlation between the two.

This complete non-relationship is probably due to the separate funding of arms purchases in Chile, through the 10% royalties on copper sales by Coldeco (previously a 10% share of profits). Scheetz (1996) adds that the armed forces frequently borrow ahead on the copper account, which further enables them to insulate themselves from current budgetary limitations.

Attempts to explain Chilean arms imports in terms of economic variables, or in terms of neighbours' arms imports prove fruitless. Equally fruitless are Logit and Probit models which attempt to explain the 'spikes' in Chilean military spending that occur in 1973,1974,1976,1982,1984 and 1995. It seems hard to reject the hypothesis that Chilean arms purchases have simply followed an independent procurement cycle, with periodic large spends to replace obsolescent equipment or acquire new generations of weapons, without regard to any economic, political or external factors.

Some confirmation of this can be obtained by looking at 10-year moving-averages of the arms imports series for Argentina, Brazil, Chile and Peru. (Figure 8 below).

Figure 8



The Argentine and Peruvian series still show the familiar rising, falling and levelling out pattern apparent from the military spending series and the shorter 4-year moving averages, while the Brazilian series shows a falling and rising pattern, again in keeping with the military expenditure pattern. But the Chile series shows very little variation at all, being virtually a flat line. The coefficients of variation of these series bear out this impression: Argentina 0.55, Brazil 0.39, Chile 0.10, Peru 0.48. It seems that the policy of the Chilean armed forces is to maintain their arms acquisitions at a more or less constant average level over a roughly 10-year horizon.

Co-integration for Brazil and Chile

Looking for co-integration seemed most natural for Argentina and Peru, where the relationship between military spending and arms imports was closest, but for comparison, this approach was tried for Brazil and Chile. In the case of Brazil, this might be expected not to work so well, as the relationship seemed much weaker in the seventies. However both series appear to be I(1), and the Johansen method found evidence of co-integration, with a coefficient of around 3 of log military spending on log arms imports in the co-integrating vector. The convergence rate was very fast, as for Argentina and Peru. In the case of Chile, the series for arms imports was I(0). If the Johansen procedure was nonetheless (inappropriately) followed, the results showed an apparent 'co-integrating' vector, but with the wrong signs – in other words showing a negative 'long-run' relationship between arms imports and military spending. This seems to reinforce the hypothesis that the two variables are more or less unrelated in the case of Chile.

A6.4. Conclusions

The cross-country regressions have given a picture of the demand for armaments that broadly reflects that for military spending. The most important conclusion is that a country's arms purchases depend on GNP and on the arms purchases of their rivals. In other words, given a fixed level of resources, a country's armaments decisions are chiefly a response to the arms acquisitions of those countries that pose a threat to them. This conclusion must be adjusted to account for those countries that can produce their own arms, and for certain regional effects, but in essence what we have found is consistent with a very generalised concept of an arms race, or rather networks of local and regional arms races between groups of rivals. On the other hand very little evidence was found to suggest that the level of arms acquisitions by non-hostile neighbours was relevant, though this was marginally significant in the post Cold-War period.

In the South American case studies, the picture was far murkier, and the results give very little empirical support to the hypothesis of an arms race, or a network of arms races, amongst the main arms buyers in South America. This was despite looking at numerous models, including logit and probit models to explain the 'spikes' in purchases. The level of arms purchases by Potential Enemies was found to be marginally significant however when data for the four countries was averaged over 5-year periods and then pooled. More significant were economic factors, namely GDP and levels of debt.

More insight was gained through exploring the relationship between military spending and arms. In Argentina and Peru this relationship is very close, so that in the medium term there does not seem to be any distinction between the demand for military spending and the demand for arms in these countries. In Brazil, the series only appeared to be moving together from the eighties, though co-integration could still be found. In Chile, the best explanation of arms import levels seemed to be that they are roughly constant when averaged over ten years.

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