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# A European Defence Union

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Summary : National defence arrangements appear to be increasingly complex due to budgetary pressures, rising costs and changing threats. There is a risk of massive investment in defence at a time when threats are diminishing, when Europe remains completely dependent on the United States and in a context where a policy of effective neutrality could be imposed through structural disarmament. Threats to European interests may not find echoes and support from the US Government. There are clear advantages to joint procurement by member countries because of the high fixed costs of R&D and the learning curve effects associated with weapons. The main problems to be resolved concern the differing perceptions of national interest among states, highly heterogeneous military strategies and competing industrial interests.

Les dispositions nationales de défense semblent de plus en plus complexes en raison des pressions budgétaires, de l'augmentation des coûts et de l'évolution des menaces. Il y a le risque d'un investissement massif dans la défense à un moment où les menaces diminuent, où l'Europe reste complètement dépendante des États-Unis et dans un contexte où une politique de neutralité effective pourrait être imposée par le désarmement structurel. Il est possible que des menaces qui pèsent sur les intérêts européens ne trouvent pas d'échos et d'appui de la part du gouvernement des États-Unis. Les achats communs des pays membres présentent des avantages évidents en raison des coûts fixes élevés de la R&D et des effets de la courbe d'apprentissage associés aux armes. Les principaux problèmes à résoudre concernent les divergences de perception de l'intérêt national des États, des stratégies militaires très hétérogènes et des intérêts industriels en compétition.

Keynotes : European Defence Union, Military expenditures, armament industries, military strategies, NATO, USA

Défense commune de l'Europe, dépenses militaires, industries d'armement, stratégies militaires, OTAN, USA

## **1. Introduction.**

In 1954 the French assembly vetoed plans for a European Defence Community. This veto led to West Germany joining NATO the following year and the establishment of a durable defence structure, within which European security was shaped by US hegemony and guaranteed by US nuclear deterrence. For the 35 years, while this structure lasted, the idea of any supra-national European defence organisation remained a political fantasy. Then interest in some form of European Security Organisation was rekindled by the end of the Cold War; the re-unification of Germany; the declaration that NATO and the Warsaw Pact were no longer adversaries; the signing of the treaty limiting Conventional Forces in Europe (CFE); and the removal of a large number of US forces from Europe. The Italian government proposed that the European Community (EC) extend its remit to defence matters, and the issue was placed on the agenda of the EC Inter-Governmental Conference on Political Unity. Germany and Britain accepted in principle the French proposal that the Western European Union (WEU), the primary European military organisation, should develop much closer links to the EC and become NATO's "European Military Pillar". Even neutral Ireland accepted that the Community's role in security policy should be discussed.

However, the fragmented European reactions to the crisis that followed the Iraqi invasion of Kuwait in August 1990 and the war that followed in 1991 demonstrated to some that any common European security organisation remained a fantasy. Yet to others the lack of coordination indicated the absolute necessity for an organisation capable of orchestrating a coherent response; otherwise Europe would be left marginalised, dependent on the vagaries of US decision-making. Any supra-national

European defence organisation can easily be dismissed as a "day-dream", as it was by the British Secretary for Defence in a Parliamentary Answer in October 1990. But the issue is almost certain to remain a topic of debate, not least because of the powerful financial and military incentives for cooperation, which arise from the inherent economies of scale in the production of power. Furthermore political equilibria can shift rapidly, as they did between 1989 and 1991, and the system has not fully adjusted to these shifts. In such circumstances, structured analysis of alternative scenarios provides the basis to respond to unexpected events.

Nor is European defence merely a matter of political and military interest, it raises important economic questions. Unless economists address them seriously, there is a risk that these questions may be answered badly, with the consequence that economically inefficient institutions will be created by default should the political equilibrium shift. Leaving the economics of European defence policy to the military community poses the same dangers as leaving the economics of European agricultural policy to the farming community. The economic dimension is important because very large amounts of money are involved – the British and French programmes to modernise their submarine launched ballistic missile systems, Trident and le Triomphant, will each cost much more than the Channel Tunnel – and defence programmes have major implications for European high-technology industry. The economic dimension is also interesting because of the subtle analytical issues associated with the supply of international public goods and the principal-agent problems associated with procurement and provision.

This paper will provide some background to defence policy and examine the analytical issues that would arise in the creation of a European Defence Union, including the membership, net benefits, resourcing, force structure and procurement policy of a possible EDU. The general argument of the paper is very simple. There are considerable advantages associated with an EDU, since it appears to offer large potential efficiency gains. These gains may outweigh the possible political losses because pressures on defence budgets, the rapidly rising cost of meeting military commitments, and the crisis of overcapacity in the defence industry will make national provision appear increasingly



unsatisfactory. Defence has aspects of an international public good, but the potential welfare gains from a European Defence Unions (EDU) arise not primarily because free-riding has caused under-provision in the past but because efficiency improvements could result from the economies of massing forces and rationalising procurement. However, there is a danger not only that those potential efficiency gains would be extracted as rents by military interests, but that the formation of an EDU would create political barriers that would allow these interest groups to extract even larger rents and provide them with incentives for further rent-seeking activities. To put the problem crudely, there is the danger that a Common Armaments Policy would add a tank mountain to the butter mountain of the Common Agricultural Policy.

Section 2 sets out the background. The formation of an EDU poses fewer operational problems than most people imagine since current European military co-operation provides a well-developed framework. Section 2.1 sets out the economics of the alternative, national provision, and the tensions that are likely to develop. Section 2.2 examines the basis for military co-operation in Europe. The theoretical framework that will be used to analyse the problem is set out in 2.3. Sections 3 and 4 examine the possible efficiency gains in the production of military capability and the procurement of weapons and their implications for force structure and the arms industry. Section 5 examines the policy issues associated with sovereignty, contributions, and institutional design. Section 6 draws some conclusions.

## **2. Background.**

### **2.1 The Prospects for National Provision.**

The costs and benefits of an EDU have to be assessed relative to the alternative, national provision of defence. The trends in budgets, costs and threats make the prospects for national provision look rather bleak. European countries will face a choice between: spending very large amounts of money to achieve minimum efficient scale; relying on national forces which are too small and ill-equipped to provide reliable insurance;

depending on the US; or accepting a policy of effective neutrality. Cost pressures could induce "structural disarmament", forcing even large spenders like France and the UK to choose between maintaining their present balance of capabilities while cutting the funding for each, or specialising in particular roles by abandoning current capabilities. Well funded, comprehensive European forces may be preferable to either a broad range of under-funded national forces which are each too small or ill-equipped to be viable should a challenge emerge or to a narrow range of competent, but specialised forces which helpless in the face of certain challenges. Below we consider in more detail the constraints on defence budgets, the soaring price of high-technology weapons and the large costs associated with providing the capability to insure against the new less well defined threats.

Budgetary constraints have already begun to bite. Trends in US and WEU military spending are shown in Figure 1. Real military expenditures in Europe and the US peaked in 1985-6, and have been flat or falling since then. This downward pressure on defence budgets was reinforced in 1990 by the disintegration of the Warsaw Pact, the reduction in the traditional Soviet threat and the growing political pressure for a "peace dividend". Like the US, most European nations announced cuts in forces and in military budgets, and these cuts threatened the survival of various planned weapons systems. Yet alongside this downward pressure on defence budgets as a result of the decline in the traditional threat from the Soviet Union; there is also concern about the rise of new military threats, such as that posed by Iraq in the Gulf, by instability in Central and Eastern Europe, or by aggression in the Mediterranean. What would Europe do if Libya fired Scud missiles at Italy? The last time this happened, in 1986 after the US raid on Tripoli, Europe did nothing because the missiles missed their target, the island of Lampedusa.

These new threats are likely to be less well defined than the traditional Soviet threat and thus more difficult to plan for; pose risks to general European interests rather than to individual national interests; and demand a wide range of new and qualitatively different military capabilities. High technology capabilities emphasising mobility, flexibility, and versatility will be required to provide the ability to fight successfully in a



variety of different areas and geographical conditions against a range of different enemies. These enemies are now very capable. The light intervention forces which Britain and France traditionally used for out of area operations would be ineffective against the many Third World military powers to whom western countries, including Britain and France, have sold sophisticated weaponry. Characteristics such as mobility and flexibility are expensive and no individual European country would be able to afford them on its own. Many of these capabilities are infra-structural in nature. For instance, Europe at the moment lacks the heavy airlift and fast sea-lift facilities which is required to provide the strategic mobility to rapidly deploy armoured forces. Whereas the US could deploy armoured forces to Saudi Arabia rapidly, partly by using equipment pre-positioned in the area to meet an expected Soviet threat; British tanks were sent slowly to the Gulf in hired commercial Roll-on Roll-off ferries. Providing this strategic mobility would be beyond the means of any single power, but could be provided jointly. Europe also lacks the information systems needed for effective electronic warfare, and has chosen not to develop particular sorts of weapons, such as anti-missile missiles, comparable to Patriot, because of the cost.

In the past the forces that European countries, particularly Britain and France, have used outside Europe, out of area, were designed and maintained for European conflicts. With the reduction in the European threat, these forces are likely to be run down and not be available for out of area conflict. Whereas keeping a wide range of forces could be justified by a Russian threat, the less concrete newer threats will not provide sufficient political justification for an individual country to bear the cost. Thus European countries will appear to face a choice, they can maintain "penny-packet" national forces, incapable of projecting power or defending interests beyond their boundaries and rely on the US to act to defend such interests; or they can pool their budgets to create forces that could be used in their joint interests.

For continued dependence on the US to be a viable alternative requires two conditions. Firstly, the US must continue to think it worth bearing the economic burden of maintaining and using global intervention forces. While the benefits to US national interests of global power projection are diffuse, the costs are considerable and

quantifiable. Forces stationed abroad cost the US \$14 billion in 1989, the 1991 figure will be considerably higher the exact figure dependent on the cost of the Gulf War and the size of the payments to the US by other countries. Over half the US defence budget, \$150 billion, is attributable, on some calculations, to NATO. Kennedy (1988) popularised the notion that US economic decline, like that of previous Great Powers, was partly a consequence of excessive military commitments: "imperial overstretch". Europe cannot guarantee the political willingness of the US to continue to shoulder this burden.

Secondly, the US must act in Europe's interests. With some major exceptions like Suez and Vietnam, European and US interests have largely coincided in the past and Europe has contributed to the protection of those interests, albeit an inadequate contribution in American eyes. In those circumstances dependence had attractions. In the future, if a reduced European contribution give Europe less leverage over the US and a reduced Soviet threat makes Europe less central to US interests, dependence may be less attractive. Dependence on the US also signals the political message that individual European states believe that the commonality in military interests between them and the US is greater than that between them and other European states. Table 1 presents opinion poll evidence from 1989, which indicates that the majority of Europeans believe this to be the case. They trust the US to defend them more than they trust their neighbours. In the past, a range of special interests contributed to this pattern: Benelux preferred US military hegemony to that of their large neighbours; West Germany needed the US strategic nuclear guarantee; France and Britain shared global interests with the US. In the future such commonality of interests may be less plausible.

If independent national action is unaffordable and US action unforthcoming, the European nations could make a virtue of necessity and follow Switzerland, Sweden and Austria and adopt explicit neutrality, with non-provocative defence forces geared solely to the protection of national territory. This would be a break with tradition, particularly for Britain and France, but Nearly all EC members have maintained some forces that can be used to project power, and individually if not jointly deployed them abroad after the Iraqi invasion of Kuwait, see Box 1. Despite this there are strong arguments for neutrality and it may appeal to majorities in some of the smaller EC members, and



perhaps to important elements within United Germany. Neutrality would however conflict with existing treaty obligations within NATO to come to the aid of any member state who is attacked.

## 2.2 European Military Cooperation.

Military cooperation can take many forms. There are confidence building measures such as notification of troop movements and exchange of military staff; treaty obligations to come to the aid of an ally if it is attacked; integrated military commands which would come into operation in case of war; common procurement and standardisation of weapons; joint provision of infrastructural facilities; and multi-national forces which mix nations under joint command in peace-time. Examples of all these forms currently exist in Europe and as a result European armed forces are already tied together in a patchwork quilt, with strong bonds between each piece but no overall pattern.

The patchwork effect is the result of the proliferation of security related organisations, which have arisen because different coalitions of countries form on different issues and each coalition requires a forum of its own. The major organisations are the EC, NATO, WEU, IEPG, and CSCE, and in addition subsets of countries cooperate separately, e.g. Germany, Italy and the UK to build Tornado. Membership of the various organisations is shown in Fig 2.

The EC coordinates foreign policy initiatives, but defence was excluded from its remit by article 223 of the Treaty of Rome. However under article 30 of the Single European Act the Community has the responsibility to maintain the technological and industrial conditions for security, which provides an entry for the Commission to become involved in military procurement. Security cooperation is being discussed in the inter-governmental conference on political union, and Jacques Delors the European Commission president has proposed that a common European defence policy be written into a new treaty of union.

NATO is the primary military organisation. All the EC members except neutral Ireland are members of NATO, but it also includes non EC members the US, Canada, Turkey, Norway and Iceland. France is a member of NATO, but not of its

integrated military command and does not see NATO, which is dominated by the US, as a European organisation. In Europe, France has refused to allow its troops to come under foreign command; in the Gulf, military necessity required that they operate under US command. Whether this experience will change French attitudes to NATO is unclear. NATO as a whole is currently trying to develop a new strategic philosophy that takes account of the end of the cold war.

During the post-war period, the Western European Union, the oldest of the organisations, has been rather like the dormouse in Alice in Wonderland. Every now and again it wakes up and does something and then it goes back to sleep again. The French woke it up in the mid 1980s, and it developed a Security "Platform" and co-ordinated European Naval Forces during the Iran-Iraq War. Its function has often been to be a bridge between other organisations, and in February 1990 its members proposed a strengthened defence policy which would link the WEU to both the EC and NATO.

The Independent European Programme Group (IEPG) attempts to coordinate defence procurement to gain the benefits of the economies of scale discussed in sections 3 and 4. So far it has had little success. The Conference on Security and Cooperation in Europe (CSCE), which arose from the Helsinki Final Act, includes nearly all European states including those that were in the Warsaw Pact, and is the framework for the CFE arms control and the Confidence and Security Building Measures.

In political terms, the core group is the WEU. They are a geographically contiguous set of non-neutral members of both the EC and NATO, who already cooperate extensively, including on military procurement as members of IEPG. For the rest of this paper, the WEU countries will be taken as the basis group, but operating in the context of evolving EC, NATO, and CSCE organisations. The WEU could become the security arm of the EC. Security objectives derive from foreign policy interests, and since the EC already strives to co-ordinate its foreign policy, it is sensible for it to extend that co-ordination to security policy. In terms of the evolution of a united Europe, a defence union is a natural successor to a single market and economic and monetary union. However, EC institutions are already overloaded with decision making on agricultural, economic and monetary issues; while Irish neutrality, Danish



quasi-neutrality, the geographically peripheral position of Greece, and pressures to extend the EC to include EFTA and possibly Eastern European countries may make military negotiations difficult. Thus the WEU as a sub group of the EC may be more effective route to cooperation. The WEU could also be the inheritor of NATO's unified military command. NATO already integrates military activities on a significant scale, but it is not seen as a European organisation, and the French and Spanish do not participate in its military activities. If, as a consequence of its troop withdrawals from Europe and its concern with conflicts elsewhere, the US came to have a less dominant and over-whelming role in NATO, the scene might be set for a non-American Supreme Allied Commander in Europe, which might allow France & Spain to join an integrated military command. The product of this symbiosis could then evolve into a European Defence Union with a small North American contribution, linked to the non-WEU NATO members. The UK is more likely to support this route than an explicit military dimension to the EC. Finally such developments would take place in a wider European context in which the CSCE is likely to play a major role, involving Eastern Europe and the Soviet Union, and in a world context in which the UN would be the responsible organisation.

In military terms, cooperation in Europe is deep and habitual thus there is a reservoir of operational experience which is potentially transferrable to any new structure. Although this experience is regularly exaggerated or minimised for political reasons, it is driven by sound operational reasons, such as the need to minimise fratricide, damage by friendly fire in conflict. In the crowded air over Europe, the practical necessity for the sophisticated coordination of military flying has engendered high levels of integration. Even during the Cold War, NATO and Soviet Navies developed joint operating procedures to avoid collisions between their ships. An integrated training operation for the German Italian and British air forces using the Tornado has been established.

The strongest bond is the NATO integrated military command. Although France and Spain do not participate in this, they regularly participate in naval exercises, and there is an extensive exchange of information. Countries assign forces to NATO, and

in case of war these forces would come under NATO command. The Supreme Allied Commander in Europe, SACEUR, is a US General who reports to the political leaders on the North Atlantic Council. The integrated command system is regularly tested by "command post" and "live" exercises. The former testing decision making and communications, the latter also involving the movement of troops and simulated battles. There are a number of multinational forces that operate under NATO in peacetime. These include the Allied Command Europe Mobile Force, AMF; the UK/Netherlands Marine Force, which is a binational force meeting multilateral commitments; and the 18 E3A AWACS aircraft operated jointly by 13 NATO countries, the UK and France operating separately. AMF integrates forces from seven nations, in a formation which is designed to be available for deployment on 72 hours notice. NATO deployed the airborne component of the AMF which included German, Italian and Belgium squadrons, to Turkey before the start of the Gulf War.

A range of NATO activities are funded jointly, including the purchase of the AWACS, the infrastructure programme, and a maintenance and supply agency. Infrastructure is paid for on a complicated cost-sharing formula: NATO does not hold funds, countries compensate each other for differential expenditures. Large systems include the NATO Air Defence Ground Environment, NADGE, to be replaced by the Air Command and Control System, which integrate radar and aerial surveillance. NATO also runs a range of groups which try to promote standardisation and inter-operability of procedures and equipment. There is a range of other bilateral integration, such as Franco-German exercises and the Franco-German Brigade.

Language, in itself, is not a major obstacle. Most armies from the Roman to the Russian have been multi-lingual. The issue is deciding which language to use and who commands and controls, a political problem. The NATO integrated military command operates as it does because of US hegemony, by virtue of the large US contribution and the deterrent, who would command a European NATO is less clear. Within a symmetric alliance there is a trade-off between commitment and freedom of action. Each nation would like the other partners to be fully committed, but maintain as much freedom of action for itself, with symmetry this is impossible and countries have to sacrifice freedom



to gain commitment. Between the US and Europe, NATO was never symmetrical, since it was the US who had the strategic deterrent. Within Europe the alliance would be much more symmetrical.

The advantage of an EDU is that while individually European states might have few military options, jointly their capability is substantial. The disadvantage is that decisions about the use of that capability will have to be shared. Table 2 gives 1989 figures for their military expenditures, incomes, armed forces, and stocks of certain weapons, compared to the US. While their combined GDP was 90% of that of the US, their combined military expenditure of \$145 bn was a little less than half the US total. Despite the lower expenditures, the WEU fielded more troops than the US, since half of its troops are relatively cheap conscripts. Of course the budgetary cost of conscripts understates the resource cost to the economy, Fontanel (1991) discusses the issue. Over 70% of the WEU expenditure comes from the 3 largest states, UK, France & Germany, each of whom spent about the same amount in 1989 and who also account for the bulk of the forces. Confining membership to WEU states might offend the other EC and European NATO members: Ireland, Norway, Denmark, Greece, and Iceland (who has no armed forces). But adding these 5 raises political and military difficulties and only adds 6% to the total military expenditure available to the union. The relationship to Turkey a NATO member also raises problems.

The table represents a historical snapshot that has been overtaken by events. Numbers of troops and weapons are subject to restrictions under CFE and most of the countries involved also planned reductions, prior to the Gulf War. The CFE Treaty provisions for European forces are shown in Table 3. East German forces will be merged with the West German ones, subject to an upper limit of 370,000, of which not more than 345,000 may be ground and air forces. Compared with the notional 670,000 troops that were fielded by the joint German forces, this is a substantial reduction, and there will be comparable reductions in weapons, primarily by the disposal of East German equipment. Overall, the WEU fields total forces which amount to roughly three quarters those of the US, the world's dominant military power. The French and British deterrent forces also provide the WEU with a substantial tactical and strategic nuclear capability. What

table 2 does not show is less obvious infrastructural capabilities, which Europe lacks relative to the US. These include strategic mobility such as air-lift to project rapid deployment forces and C<sup>3</sup>I (Command, Control, Communications and Intelligence) infrastructure such as satellites. To provide these would require joint funding of large projects.

Added together the WEU countries, while not rivalling the US, constitute a formidable military power, and as section 3 will argue rationalisation under integrated military command could increase that military capability. This potential to act will appear attractive relative to the alternative of small national forces with few options. Furthermore, if European states judge that future threats, while difficult to predict individually, as were the invasion of Falkland/Malvinas and of Kuwait, are likely to impact on them in a similar way; that no individual state can afford to maintain appropriate forces to respond to all the possible contingencies; and that it is important for Europe to have the capability to project power independently and not be too dependent on the US; then the case for an EDU will appear even stronger. But these political judgements will need to be made in the context of an economic analysis.

### 2.3. Defence Planning: an Analytical Framework.

The general structure of the defence planning problem, which is used in the economic literature, is based on five relationships. A schematic version is set out in fig 3. There is an alliance of N states, which face a common enemy, but make individual decisions about national force levels. Subsequently, we discuss how joint forces of the sort that might be provided by an EDU would shift these relationships. The budget constraint is that:

Output (Y) can be used for Military (M) or Civil Expenditure (C)

$$Y_i = M_i + C_i \quad i=1..N \quad (1)$$

Military expenditure is used to provide

Armed Forces (F) which provide Alliance (A) and Domestic (D) Protection:

$$F_i = A_i + D_i. \quad (2)$$

Part of each independent national force provides a public good for the alliance, joint protection against common threats, even though they are under national control:



German troops in Germany provide the first line of protection against Soviet attack for France. Another part provides a private good to the nation, domestic protection against country specific threats, such as the French, British and Portuguese Colonial Wars; and Greek and Turkish preparations against each other. Murdoch & Sandler (1984) also suggest that while deterrence – the prevention of attack – may be a pure public good; defence – the response to attack – is much more likely to be country specific. The division between alliance and domestic protection depends on the threat. Whereas it is clear that German ground forces and British naval forces in the Atlantic protected France from Soviet attack from the North and interdiction of French shipping, their northern deployment precludes their use to provide protection against threats to French interests in the Mediterranean, such as an attack or an influx of boat people from North Africa. Thus with the decline in the Soviet threat the externalities provided by independent national forces may decline.

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Military expenditure is the cost of providing the amount of each type of force:

$$M_i = M_i(A_i, D_i). \quad (3)$$

This cost function allows differences in the efficiency of provision between countries. The most obvious example is conscription, which allows more troops at lower budgetary cost, but other aspects of this function will play an important role and are discussed further in section 4.

Welfare (W) depends on Security (S), Civilian Expenditure and Population (N):

$$W_i = W_i(S_i, C_i, N_i) \quad (4).$$

Population appears because security or defence is a public good. Whereas it is per-capita civilian expenditure that matters to welfare, security is provided to the whole country. On this basis, we would expect countries with large populations to spend a larger proportion of their income on defence, which is the observed cross-section pattern. The details are discussed in an appendix.

Security depends on the armed forces and the threat (T)  
of the allies to country i:

$$S_i = S_i(A_1 \dots A_N, D_i, T_i). \quad (5)$$

This is a military effectiveness "production function" which converts quantitative forces

into the capability to deter, defend or attack which provides security, and is discussed further in section 3. It allows the impact of the threat and the marginal security protection of the alliance to differ between countries. Shifts in the organisation of forces, e.g. the creation of an integrated military command and joint forces, represent shifts in this production function. Within this framework, we would tend to expect that a reduction in the threat will increase security, reduce the marginal benefit of armed forces, and tend to result in reduced military expenditure; though other results are possible. We have taken the threat as exogenous, but if the size of enemy forces respond to allied decisions, then we get 'arms race' models, more complex strategic interactions, (e.g., Garfinkel 1990) and the possibility that a cooperative arrangement to increase defence spending within the alliance, may make the alliance worse off because of the antagonists' response, (e.g. Bruce 1990).

Optimisation to determine their individual  $M_i$ ,  $F_i$  and  $C_i$  is then done interactively by the  $N$  allies. The interactions can take a number of forms, McGuire (1990). It may be a non-cooperative Nash-Cournot equilibrium, where each country individually optimises the level of its own armed forces taking the others reactions as given, or as a cooperative Lindahl equilibrium in which the alliance total,  $\Sigma A$ , is regarded as the choice variable with a shadow price given by the countries share of the total cost:  $A_i/\Sigma A$ . Both involve private provision, i.e. national forces, rather than public provision, joint forces for the alliance as a whole. The net benefit of an EDU to each state would depend on the security provided by the pooled joint forces, less the direct and spill-over benefit that would have been provided if that money had been spent on individual forces, plus the cost savings that arise from pooling.

Within this broad framework the formation of an EDU poses four issues, which for the benefit of economists unfamiliar with the military terminology can be thought of as its impact on demand, production, product differentiation, and regulatory structure.

Demand for military expenditure by countries within an alliance poses familiar public good problems, since there are spill-overs from their expenditures onto their allies. If these spill-overs are not currently taken into account, the formation of an EDU by internalising the externality will correct the sub-optimal provision and lead to increased



expenditure and greater benefits. This issue, usually known as "burden sharing" is discussed later in this section and further in section 5.

Production of military power has many characteristics of a natural monopoly. Joint forces provide more power than the sum of individual forces and can be produced more cheaply. This issue, usually known as "standardisation and inter-operability" is examined in sections 3 and 4. Empirically it is likely to be the most important effect so the evidence is considered at some length. Formation of a monopoly, the EDU, takes advantage of this cost structure and offers large potential efficiency gains, which if realised would generate considerable benefits.

However, the monopoly produces a homogenous product, European forces, rather than the differentiated products, national forces, currently produced, thus there is a loss of utility. The extent of this loss depends on the differences in national preferences. The size of the preference difference will depend on the commonality of national interests within Europe and the value attached to sovereignty, issues discussed in section 5.

Monopolies raise the issue of appropriate regulatory structure to minimise exploitation of their position and unproductive rent-seeking. Armed services are monopoly suppliers of a product, particular types of military force and capability, at a price their budget. The monopoly profit is absorbed in expenditures to meet their interests rather than the general interests. As will be emphasised throughout the paper, the military arena offers great scope for exploitation of this monopolistic position and for rent seeking activities to acquire such monopolies. This is the problem of the military industrial complex that President Eisenhower warned against, and the scope for institutional barriers to such tendencies will be discussed in section 5.

Before examining the detail, it is useful to examine the possible demand response. Suppose military spending is a pure public good for the alliance, and that countries follow Cournot-Nash behaviour, choosing their individual optimal level conditional on the spending of other countries. With a unit income elasticity (which is accepted by the data) the system above gives us a demand equation:

the share of                      depends                      Population N

military expenditure on the Price of military forces P  
in GDP: Allies spending A and  
Threats,  $T_s$  and  $T_o$

$$M/Y = F(N, P, A, T_s, T_o)$$

Threats are disaggregated into  $T_s$  the Soviet threat; and  $T_o$  other threats.

We want to consider the effect of forming an EDU from the WEU. This replaces seven small countries by one large country in stages. The analysis will be done in stages, which can be thought of as the extensive form of a game, and that decision makers will be looking forward through these stages.

Formation of an EDU from the WEU effectively increases the population of the state. Going from the 1989 cross-section relationship between the share of military expenditure and population (see appendix) this would raise the WEU share of military expenditure from its present 3.1% to 6.5%, equivalent to a total of \$300 bn in 1989, about the same military spending as the US. This is not surprising since they have similar populations and GDPs. The increase is a result of internalising the public good externality among its members. If this model is correct, the current level of under provision is quite large.

Formation of an EDU also shifts from private provision of the public good by separate nations to joint provision. Because of the large duplicated fixed costs and economies of scale in provision and procurement, joint provision results in large efficiency gains. These are discussed in sections 3 and 4. This amounts to a shift in the supply curve and a drop in the effective price of armed forces by about 30%. This increases demand, and with a price elasticity of demand for military expenditure of about a half (e.g. Lichtenberg (1989)), the share of military expenditure in GDP would fall about 15% to 5.5%, but there would be an increase in military capability.

Relative to these 1989 based estimates, the Soviet threat is likely to be much lower in the 1990s because of the collapse of the Warsaw Pact. Using the estimates in Smith (1989), this would suggest that the EDU share of military spending in GDP would be about 1% lower, say 4.5%. This is a cut broadly comparable to that announced by the



US in response to the end of the Cold War.

But the US now has a large new partner, spending 50% more on defence than before. This will allow the US to reduce its military expenditure, particularly that incurred for the defence of Europe. About half of US expenditure is NATO related, and they might cut that portion by a third, reducing their share of GDP by about a further 1%. The EDU will then have to spend more to compensate for that cut, perhaps making up half, pushing the EDU share back to 5%. This assumes that the US continues to see Europe as an ally rather than a rival that must be matched.

The Soviets now have a well organised military super-power on their border spending about \$230 bn a year. It is quite possible that they would regard this as highly threatening and respond by raising their own military expenditure. The EDU now being less dependent on the US, would have to match at least part of this increase in order to maintain security. It is not obvious what the slopes of either of the Soviet or EDU reaction functions are likely to be; though an unstable arms-race could not be excluded a priori.

On this scenario, formation of an EDU, with consequent higher but more effective military expenditure, less dependence on the US and increased Soviet-European military competition, could result in either an increase or a reduction in overall welfare. If defence spending is not a pure public good for the alliance, joint provision may also result in private, national, security needs being left unmet.

The analysis so far ignores the other threats than the Soviet Union. The Iraqi invasion of Kuwait has brought these into prominence, and also brought home that what were usually thought of as purely regional powers are now often very well armed. Thus the light intervention forces used in the past, e.g. for Shaba I & II and the Falklands, are under equipped. However, the EDU, unlike European states at the moment, would be able to afford well equipped rapid deployment forces with the critical mass and mobility to make them effective. The EDU would then have the option of an interventionist military response to potential threats in the band of instability that surrounds Western Europe: from the Baltic States, through Eastern Europe and the Middle East to North and Sub-Saharan Africa. Britain and France have interventionist traditions of projecting

power, though other WEU countries do not. It is not clear what approach a joint EDU would adopt, nor whether such international military interventions would be stabilising or destabilising.

Of course, if we assume that there is already a Lindahl equilibrium within the WEU, and that as a group they have already internalised the externality, conditional on US spending, the effects are much less dramatic, since baseline levels of spending would not change. While in principle it is possible to decide econometrically whether Cournot-Nash or Lindahl is a better description, in practice estimates conflict. The evidence is further discussed in section 5.

### 3. The Production of Military Power.

This section examines equation (3), the process by which forces are transformed into power, the military capability which can be used to maintain security. This is the stuff of much military operational research, here it will be examined in terms of economic characteristics. Power has the property of a natural monopoly: the effectiveness of the sum of the forces is greater than the sum of the effectiveness of smaller units. This property will be examined in terms of the returns to scale, indivisibilities, optimal input mix and division of labour associated with the production of military power.

The inputs into the equation are both quantitative, numbers of troops and weapons with measurable performance characteristics and qualitative, the intangibles of war. Although we will tend to emphasise the quantitative aspects, the intangibles are almost certainly more important. In combat, surprise, leadership, morale, training, logistics matter more than "bean counts" of the number of troops and weapons and their measurable performance characteristics. In 1940 Britain and France had more tanks and troops than Germany, and an established defensive position, yet they lost. The intangibles are not discussed because economists have no comparative advantage in assessing them, not because they are unimportant. Section 3.1 examines the increasing returns to scale that arise in the production of military power because an increase in inputs provides a more than proportionate increase in capability. Section 3.2 examines



some important indivisibilities in the provision of capability. Both factors mean that formation of joint forces could produce efficiency gains. Section 3.3 examines some important trade-offs in the input mix: conscripts or volunteers, quantity or quality of equipment; nuclear or conventional. Section 3.4 considers the international division of labour.

### 3.1 Economies of Scale.

As Voltaire noted, God is on the side of the big battalions. Big battalions have a variety of advantages. Pure increasing returns to scale are a phenomenon of massed combat. Other things being equal, a balanced increase in the numbers of a force (more troops, more tanks, more support vehicles) has a more than proportionate increase in the probability of winning. This is because a small advantage in numbers can explode into a large advantage, because of the cumulative effect by which each time you destroy an opponent you also reduce the attrition you suffer, leaving relatively more of you to attack them. The classic model of this process, developed by Lanchester in 1916, suggests that security, in the sense of probability of winning, is a quadratic function of numbers, see appendix A. The model was developed for a single battle between massed forces, but if it was applicable to total tank forces the relative combat effectiveness of unified to disparate WEU tank numbers would be the ratio of the square of total tank numbers, to the sum over the 7 countries of the squared numbers; a ratio of about 4 to 1. This exaggerates the gain, but the ratio is almost certainly greater than unity. Some of the potential efficiency gains can be exploited by partial measures, such as alliances, joint military command as with NATO, and multi-national forces.

There are further sources of economies of scale and scope in spreading fixed costs and synergies from related activities. Unified command allows the formation of big battalions, which can take advantage of centralised control, standardised weapons and procedures, concentration of forces, critical mass and the formation of mobile reserves. Co-operation not only provides the potential to deploy much greater power but concentrated forces have a more than proportional advantage over dispersed forces. Whereas, in less than a decade Bismark was able to overturn the balance of power in

Europe by three successful wars, fighting nations one at a time; he would have been unlikely to defeat those three countries, had he fought them jointly.

Numbers matter, and the economies of scale in the production of power mean that unified forces can pack more punch in combat than equivalent numbers of fragmented forces, providing an incentive for security cooperation among states sharing common interests to integrate and concentrate their forces. For instance, almost all European countries have recognised the need for some form of rapid deployment force. These include the French Force d'Action Rapide, the Italian Forza de Accion Rapida, the Spanish Fuerza de Accion Rapida, Portuguese Airborne Brigade, the UK Mobile Force, and the Belgium Paracommando Regiment as well as the NATO Allied Command Europe Mobile Force. They differ in size, equipment and mobility, but each individually have quite limited capabilities, particularly in terms of armour and air-mobility and would have difficulty competing with the many Third World powers who now have sophisticated weaponry. At less than the joint cost a single European Rapid Deployment Force that was smaller in total numbers, but much more capable could be constructed.

### 3.2 Threshold levels and capabilities.

The production of power is characterised by indivisibilities, such as the need for a minimum viable force size: below some threshold number no benefit is obtained. For instance, for deterrence to be effective, at least one nuclear missile submarine must be on patrol at all times. To guarantee this with reasonable certainty requires a force of four submarines. Thus the marginal benefit of a system is zero up to some threshold level, then becomes positive, falling with further numbers. Over time real costs have risen rapidly with technological enhancement, growing at about 6% to 8% per annum between each generation of weapons, each of which can cost three or four times its predecessor. The response to this has been to reduce the numbers of systems, airforces have a fraction of the number of aircraft they used to have, and increase their length of life. A lot of military equipment is very old, albeit fitted with more modern electronics. The US used a Second World War battleship in the Gulf War, and UK airborne early warning in the 1990s was provided by a 1940s aircraft, the Shackleton. 1950s Buccaneers and B52's also



saw service in the Gulf War.

At some stage, the number affordable falls below a critical threshold, and the country withdraws from maintaining that capability or refuses to develop some expensive new capability. Declining defence budgets, shift the demand curve lower, pushing more countries below those thresholds. For instance, the traditional aircraft carrier, of the sort that the US and Soviets deploy, has become far too expensive for European states. The French continue to agonise over the cost, but even if they proceed they will have to equip it with obsolete aircraft. The British, Italians and Spanish, have moved down a step to smaller vessels with vertical take off aircraft: Harriers and helicopters. Since none of the Europeans can afford the support that an US Carrier Group contains, their vessels are also very vulnerable.

The question then becomes, what type of forces to retain? Prior to 1990 the design of force structure, while not easy, was straightforward. Forces were designed to meet a Soviet threat. Other threats were met by transferring forces designed to counter the Soviet threat to other areas such as the Falklands, the Gulf, Chad, etc. Post 1990 with the Soviet threat receding it is no longer clear what contingencies forces should be designed to deal with. Forces which were once used to sustain a very durable order, now have to be available to shape what may be a very unstable evolution. The forces have to be much more flexible, not optimised for a specific scenario, very mobile, capable of being moved quickly to where they are needed and the design has to be much more robust capable of performing well enough whatever contingency.

Flexibility, mobility and robustness are expensive characteristics. They require large investments in heavy airlift, pre-positioning of equipment, research in re-programmable systems, big inventories, and C<sup>3</sup>I infrastructure which currently only the US can afford. For instance JSTARS (Joint Surveillance Target Attack Radar System) comprising aircraft and ground stations, which tracks land targets in the way AWACS tracks air targets is currently budgetted at \$8.2 billion, and is likely to cost more. If Europe does not feel that it will always be able to rely on the US to defend its wider interests and felt that it may need to project force further afield to meet new threats it would have to develop appropriate forces. These contingencies are less well



defined and may not be predictable, but each is likely to require specialised military capabilities. Equipment optimised for a particular environment is cheaper than that which has to operate in snow, mud or sand over a wide temperature and humidity range. Maintaining sufficiently flexible forces within a structure that is robust enough and well equipped enough to insure against any contingency is too expensive for individual European countries, but could perhaps be provided jointly out of the savings generated by cooperation.

### 3.3 Input Mix.

A major issue in the formation of an EDU is that is that the various countries are starting from quite different input mixes, having chosen to use different types of troops and equipment. This section examines three dimensions of input choice: conscripts versus volunteers; quality versus quantity in equipment; and conventional versus nuclear forces. The structural difference is most evident in a comparison of Britain and France, since they are strategically very similar, compared to the other European countries, yet have chosen very different patterns of provision. The strategic similarity arises because they are geographically close; each maintained troops in Germany; fought a series of wars in the process of decolonisation; developed nuclear capabilities; spent broadly comparable amounts on defence, at the cost to the the UK of a rather higher share of GDP; retain substantial commitments and a maritime presence outside the NATO area and contributed forces to the Gulf War. However, they have met these strategic demands very differently. The UK within the NATO integrated military command, France independently; the UK with expensive volunteers, France with cheap conscripts. The UK got its nuclear forces very cheaply from the US, France had to spend 5 to 10 times as much, often a third of its procurement budget, to obtain similar capability. The cost of the nuclear programme squeezed the conventional forces budget, so France had to build much cheaper conventional equipment than the UK and design its equipment in the light of the export demand that was needed to finance these weapons. The French military have repeatedly complained about the deficiencies of their conventional equipment, including that sent to the Gulf.



**3.3.1 Conscripts and volunteers differ in military effectiveness,** though measuring the performance of different types of troops is difficult because intangibles like training, morale, leadership and initiative are crucial to performance in combat, so there is much debate. Conscripts have a low budgetary cost (which almost certainly understates the resource cost to the economy) so more of them can be fielded for the same level of public expenditure. Conditional on income and military expenditure, across countries the elasticity of numbers in the armed forces to the proportion volunteers is about  $-0.3$ , other things being equal a wholly regular army would be 30% smaller than a wholly conscript one.

Conscripts have less experience on average than regulars and considerable resources are expended on their training. There is also dispute about the length of training required to become a proficient soldier. Certainly troops are rarely militarily effective before six months of training, two months basic and four months unit training. This is a large proportion of conscript service in many countries. Some specialist skills take much longer to acquire, four years for combat flying for instance. However, in 1989 a team of Dutch conscripts, each with less than 10 months military service, in a Leopard II won the prestigious Canadian Army Trophy for tank gunnery against teams from Belgium, Canada, Germany and the US. The UK did not participate having come last in the previous competition.

Conscript armies also provide a large reserve which can be mobilised in war. On average, conscripts may be more able or better educated if the regular forces tend to attract those not capable of getting good civilian jobs. This has been a matter of concern in the US, though not in the UK. It may also be politically difficult to use conscripts in some conflicts. The contrast between the Continental preference for conscription and the Anglo Saxon preference for regulars probably reflects not so much a judgement about military cost-effectiveness as a political tradition: the Continental association of military service with citizenship and the necessity of a close association between army and nation.

**3.3.2 Quantity versus quality, the relative weight of numbers and performance in**



producing military capability, is a subject of hot debate in weapons design. It has been widely argued that Western military decision-making, particularly in the US, has over-valued performance relative to numbers. Performance has many dimensions, for instance "stealth" characteristics, which reduce radar visibility, have been emphasised in recent US aircraft. Although the comparisons are controversial, stealth seems to have doubled the unit cost relative to non-stealth aircraft with similar missions. The F117 stealth aircraft performed well in the Gulf War, but so did cheaper F16 and A10 aircraft, and very cheap cruise missiles. Stealth may save on other costs, e.g. air-defence suppression and electronic jamming, but involves performance costs, such as sacrificing supersonic flight or agility. Trading off these characteristics requires military expertise, but this raises agency problems.

Whether in developing a new technology, or at the limits of a mature technology, performance is expensive. Adding the extra 10% can double the unit cost and produce a force that is less capable of winning than the alternative force for the same budget: one that is twice the size but without the performance enhancement. Rogerson (1990) gives some examples from air-combat of this phenomenon, and provides a model of how the separated decision making structure (e.g. Congress & Military) results in a bias towards 'excessive' quality. His model shows that if quality and quantity are poor substitutes, so that large increases in quality do not generate large decreases in quantity, then equilibrium quality will tend to be too high. This can be constrained to a certain extent by fixing the budget in advance, or, as in the French case, by requiring the equipment to be exportable. A similar asymmetry in the treatment of quality and quantity was apparent in the assessment of the European conventional balance. For what seem to have been similar total expenditures, NATO chose a 'few and expensive' force mix, rather than the Soviet 'many and cheap' mix, yet argued that the Soviet mix was more capable. Even after allowing for different relative prices between the blocks and the fragmentation of NATO decision-making, there is still evidence of inconsistency. Analysis of combat experience during the Gulf War will provide new evidence on the military effectiveness of high-technology performance characteristics, but this evidence is as likely to prolong as to settle the debate.





While weapon performance is in principle measurable, performance in trials may not reflect combat reality. Trials, such as the Canadian Army Trophy, are conducted, attributes are weighted and index numbers of effectiveness, such as kill probabilities, are constructed. These indices probably have a similar degree of subjectivity and validity as economic indices like GNP. As an example, Table 4, gives characteristics of the tanks in the inventory of 14 NATO nations in 1989. Many of the older tanks have been substantially upgraded, so age of the design is not necessarily a good indicator of effectiveness. The performance of a tank is usually evaluated in terms of three main characteristics: mobility, protection, and fire-power. Although countries differ in the weight they give to each characteristic in the trade-off, across tanks the characteristics tend to be correlated. A more powerful engine, allows faster movement, heavier armour, and more powerful weapons, and an improvement in engine power will be used to allow an improvement in all three attributes. Thus quite crude indices, such as weight, often provide a reasonable indicator of performance at a moment in time. The significance of the indicators in combat has got to be a subjective military judgement. For instance, the M1's gas turbine engine gives it high performance at the cost of high fuel consumption. High fuel consumption is only a liability, if there is a significant probability of logistic problems of supply, which there were not in the Gulf War, but may be in other conflicts. This must be a military judgement.

3.3.3 Nuclear Forces are likely to be a sensitive issue in any EDU. Although they spent very different amounts to obtain them, the British and French nuclear force structures are quite similar, and while these forces might have some credibility for minimum national deterrence, most observers judged that in Cold War conditions they were not large enough to provide 'extended deterrence' for other European countries, and thus they are no substitute for the US nuclear guarantee, e.g. Heisbourg (1989). If the Soviet threat is still regarded as dangerous the alternatives are to continue to depend on the US or to share in the massive cost of developing extensive European nuclear forces. If the Soviet threat is regarded as much reduced the minimal Franco-British forces might be seen as an adequate deterrent.

Although this is an unpromising area for creating a multinational capability, there may be some symbolic value in dedicating current nuclear forces to a European organisation, as Britain has done to NATO and there is some potential to increase nuclear co-operation between Britain and France. This could include technical areas like submarine patrol patterns and targetting, and perhaps joint development of new systems such as a longer range Tactical Air-launched Stand-off Missile (TASM), which is under discussion. However, given the changed strategic climate and budgetary pressures on both countries the value of such systems is questionable.

The central element of both countries strategic nuclear forces are submarine launched ballistic missiles. France has six submarines (SSBNs) with 96 missiles carrying 256 warheads; the UK four SSBN with 64 missiles and 192 warheads. Both are introducing new submarines and missile systems. France also has 18 Mirage aircraft with stand-off missiles, and 18 S3D Intermediate Range Ballistic Missiles in silos on the Plateau d'Albion. Both countries also have a range of sub-strategic systems and face quite difficult choices about their modernisation.

### 3.4 Division of Labour within an EDU.

To take advantage of the large potential economies of scale, requires reorganisation of production, a new division of labour. There is a spectrum of ways in which joint forces can be provided, and different ways are likely to be used in different areas. There can be Multinational units which either completely mix different nationalities, as in the NATO staff, AWACS, the French Foreign Legion and the Soviet Army; or are built up of smaller units of different nationalities, as in the ACE Mobile Force and the Franco-German Brigade. Multinational forces may be integrative, contributing to the creation of European citizens. They are also less likely to marginalise the smaller nations, who have tended to support their creation. For instance, in 1989, the Chief of Staff of the Netherlands Navy argued for an integrated UK-Dutch-German fleet. In such cases there is no funding problem, since each country contributes what it wishes in kind, ships. With truly joint forces like AWACS shares of contributions must be negotiated and paid.



An alternative to multinational forces is a division of labour: task specialisation in which separate roles are filled by separate countries, but the forces are dedicated to a unified command. High level division of labour: the British provide the navy, the Germans the armoured brigades, the French the Rapid Deployment Force: is likely to be politically unacceptable, particularly to the smaller nations, who would not have a major role; but lower level division of labour already occurs. Any of these systems will involve troops from one country coming under the command of nationals of another country. This is accepted by all the members of NATO's integrated military command. It is essential to minimise fratricide; maintain air-traffic and other movement control; and to avoid electronic and other forms of interference. In the past, France has refused to accept foreign command of its troops and this caused severe organisational problems for the operation of the Franco-German Brigade. But in the Gulf, France accepted, with some restrictions, US operational control of its forces.

#### 4. Procurement and Costs.

This section examines the procurement of military equipment in more detail. The presence of large economies of scale in weapons production, examined in 4.1, means that an EDU which rationalised procurement would generate considerable cost savings. However, defence procurement involves a severe principal-agent problem which provides scope for the arms firms to extract rents, these are examined in 4.2. At present different European countries attempt to resolve this problem in different ways along a market-oriented state-oriented dimension. The approaches are contrasted in 4.3, and the implications for the structure of the defence industry is examined in 4.4.

##### 4.1 Military Cost functions.

It seems generally accepted that to a first approximation, the total cost, TC, of producing Q weapons (in total not per unit time) can be written,

$$TC = R + BQ^\alpha,$$

R is a fixed cost, largely R&D, which typically takes about a third of total costs and  $\alpha <$

1, because of learning by doing. This is the form Arrow (1962) used and Lichtenberg (1989) estimates  $\alpha = 0.75$  for the US. Figure 4 shows the total and marginal cost-benefit structure. Benefits are zero up to a threshold minimum viable force-size,  $Q_0$ , for reasons that were discussed earlier, marginal benefit then falls with increasing numbers. Equilibrium is at the intersection of marginal cost and benefit curves, which requires that the marginal benefit curve is steeper than the marginal cost curve, subject to total benefits being greater than total costs. Lichtenberg estimates the slope of the marginal benefit curve (the inverse demand curve) for US projects as 1.8. The Figure also shows the effect of an increase in fixed costs, a typical consequence of developing technologies. This does not change the intersection, but makes net benefits negative at that level, so the country surrenders that capability in the way described in 3.2. Notice, that as long as total benefits are greater than total costs, variations in fixed costs do not change optimum numbers (any income effects on the demand curve are likely to be small). Thus, under this decision making procedure project managers have little incentive to economise on fixed costs or to avoid the temptation to 'gold-plate' the weapon with extra development expenditure. The excess of costs over benefits at equilibrium is a rent that can be extracted by the project managers by inflating R&D, if they get a consumption benefit from larger budgets or from developing technology. It is usually difficult for outsiders to distinguish what is essential from what is not.

Most of the data on the effects of fixed costs and learning curves are American. For instance, the FY 1991 budget, reduced the planned production of the US B2 bomber from 132 to 75, which was projected to save \$14.4 bn overall, but raise unit cost from \$571 m to \$814. It is also estimated that the overseas sales of 1650 F15, F16, and F/A 18 saved the US \$4bn in learning curve effects in addition to the \$44 bn direct earnings. Compared to the US, the Europeans do not get very far down the learning curve. Despite being bought by UK, Germany, Italy and Saudi Arabia, less than 1000 Tornados have been produced, whereas about 1500 F15 & F18's have been produced, and over 4000 F16s.

The potential benefits to cooperative or collaborative production which arise from cost functions like this with typical defence values for fixed costs and learning



effects are substantial. In the example graphed in figure 4 with fixed costs of 10,  $\alpha = 0.75$  and a marginal benefit slope of 2, the initial optimum is 10, with total costs of 45. If two identical countries collaborate, sharing these costs, the optimum is 13 each at a slightly lower total cost for each country. Unit costs fall from 4.5 to 3.3. This only looks at production costs, there are further savings on shared logistics, repair, maintenance, training, spare parts, etc and increased military benefits from interoperability and standardisation.

In practice, the whole of these potential gains from collaboration are often not realised, and it is claimed that unit cost increases with the square root of the number of countries participating and completion time with the cube root. Costs and completion times on collaborative projects do seem to be higher, though there is little evidence for these particular functions. Even with a cost and time penalty, collaboration is cheaper than national production, because the large fixed costs are shared. The evidence is examined in Hartley (1983) and NAO (1991). The fact that collaboration is less common than the cost savings would suggest it should be and that part of the potential collaborative benefit is wasted, arises from the nature of the bargaining process. To go ahead the collaborative project requires the agreement of the national military and arms industry. The military demand country specific performance characteristics, so there is a tendency for collaborative projects to become expensive multi-role systems. The national firms demand specific work-sharing arrangements (called the *juste-retour* principle in collaborative bargains) which require multiple production lines and giving contracts to less efficient producers to make up shares. For instance, in the dispute as to whether France would join the EFA consortium or develop Rafale independently, the French military argued that their requirement was for a lighter fighter than the other partners needed, and Dassault demanded French design leadership. In this bargaining, there is an asymmetry in threat points depending on whether the national alternative is viable, in the sense that Total Benefits are greater than Total Costs in Figure 4. If it is, national interests have an incentive to push up the costs on the collaborative project until it is uncompetitive with the national one, on which they get all the rents. If it is not, the threat point is the cost at which the collaborative project itself becomes

non-viable ex-ante, nothing is built, and the national military interests get nothing. Thus bargaining on collaboration is quite different depending on the budgetary viability of the national alternative. Ex ante, viability may not be clear, and it is yet to be seen whether Rafale with a projected requirement for 336 aircraft is affordable. In the past, collaborative programs had a further advantage to firms, because they were seen as politically difficult to cancel if ex-post they failed to meet targets. But recently it has become more common to cancel collaborative programs when they have not met their goals.

The result of the bargaining process has been the tendency to buy from national producers unless domestic purchase is inordinately expensive, and when collaboration was the only alternative to have to pay a premium to 'buy-off' the objections of national interests. When neither domestic nor collaborative options are viable, countries can either produce foreign designs under license or import 'off the shelf' weapons. The latter is usually substantially cheaper, but the former is often adopted under pressure from domestic interests. Belgium, Netherlands, Denmark and Norway formed a cooperative to jointly purchase almost a thousand new fighter aircraft. This "Sale of the Century" was won by the US F16 against European competition. Hartley (1988) estimates that the coproduction arrangements adopted to build the F16 in these countries involved a 34% penalty compared with a direct buy from the USA, and suggests that average cost savings up to 25% might be generally available to a nation that was willing to purchase its major weapons systems from the cheapest supplier on the world market.

The lobbying power of domestic interests tends to be greatest for high visibility platforms (ships, aircraft tanks, etc), where the fixed costs and learning curve effects are largest. Components, sub-systems and small arms are more often imported, so for these the cost savings from an EDU would be rather smaller. In this area, European firms seem to be very competitive and the US buys many items of this sort from Europe. Although it is impossible to verify the figure, the UK MOD estimated that the move to competitive purchase saved about 10%, and this was in a much smaller market. Given the economies of scale in Europe, an EDU, by introducing competitive purchase or centralised procurement, could save 20% on current arms purchases. This would amount



to a gain of about \$10 billion a year for WEU countries. In principle, the savings could be larger, but to realise them in practice, requires redesign of current procurement practices. The problems involved in doing this are discussed in the next two sections. Hypothetical savings alone are not likely to induce European countries to confront these problems, the Callaghan report of 1974 estimated that NATO as a whole wasted \$10 billion on redundant R&D and proliferation of national designs. What is likely to force change is not that the status quo is inefficient, but that it is unsustainable, as evidenced by the crisis in the European arms industry discussed in section 4.4.

#### 4.2 The procurement game.

Suppose a European Institution was created to realise the potential efficiency gains from rationalising procurement. It could do this either by enforcing open, value for money competition on national agencies, relying on free trade or market forces or by centralising military procurement decisions on a European scale. Either institutional structure could exploit economies of scale, but both would face similar problems which arise from the intrinsic nature of the military procurement problem, which we examine in some detail in this section. Even when not complicated by inter-national cooperation, choosing a weapon system involves complex calculations and is surrounded by large inherent uncertainty about: the appropriate specification of the system – what weapon is needed to meet the threat? the feasibility of the technology – will it work as required? and the economics of development and production – can it be built to cost and time? On all these issues the military and the arms industry have an inherent informational advantage over outsiders. For instance projects often run into major technical difficulties and costs escalate out-of control, three or four times estimates. Those best informed to decide whether these are merely teething troubles of the sort that many successful weapons systems, such as Patriot and the M1 tank, have suffered, or whether the project is a dead-end which should be cancelled, are the military and firms who run the project. But their incentives are to keep the project alive.

In deciding on procurement the MOD or a European agency will:

- (1) specify a project;
- (2) invite tenders or negotiate a bid;
- (3) choose a contractor;
- (4)

pay the contractor according to a specified formula, as development and production proceed ; and (5) may, depending on circumstances, renegotiate the contract. Each of these stages raise a range of interesting theoretical economic issues on which there is a considerable literature. The classic work is Peck & Scherer (1962), and in recent years there has been extensive work in the area by economic theorists, e.g. Baron & Besanko (1988). The theoretical literature on procurement tends to treat the legal case in which the MOD official is the principal and the firm is the agent. In the not uncommon illegal transactions the positions are reversed.

To characterise payments structure, suppose the chosen contractor has bid  $B$ , then the payment formula usually takes the form:

$$P = \bar{B} + \delta(C - \bar{B}), \text{ where } \bar{B} = B(1+i)^\gamma;$$

where  $P$  is the amount received by the firm,  $i$  is a general rate of inflation and  $C$  is the ex post measured cost of production (including agreed profit). Measured costs may not equal actual costs because of problems with auditing, attributing joint costs shared between projects. The parameter  $\delta$  can range between zero (fixed price) and unity (cost plus), with values in between representing incentive contracts. If  $\gamma = 1$ , the contract is indexed to allow for general inflation, which can be an important issue since defence contracts can last a decade or more. The case  $\delta = 0, \gamma = 0$ , is referred as a "firm price" contract. The quantity  $C - \bar{B}$  can be regarded as the "cost over-run", empirically it tends to be positive, 30 to 50% over bid is common and many times the initial estimates not uncommon. The observed cost over-runs reflect a mixture of low initial estimates, little incentive for cost control, and design changes during development. This contract is linear, but piece-wise linear contracts, with a maximum or minimum payment are sometimes used, and non-linear contracts are discussed in the theoretical literature. Laffont(1987) surveys the issues.

What makes the game between the procurement agency and the contractor interesting is the quantitative importance and interaction of a set of familiar phenomena.

4.2.1 Risk aversion is important because of the size of the uncertainty about projects which are often large relative to the assets of the firm, thus the bankruptcy constraint is



binding. Consider the case where firms are risk averse, the MOD is risk neutral and eventual costs are unpredictable because of exogenous cost uncertainty, say about technology. The MOD, pooling over many products, is better able to absorb this risk. If it does not and sets a fixed price contract ( $\delta = 0$ ), the firm will bid higher than it would with risk sharing ( $\delta > 0$ ) embodying a risk premium in the quoted price. Thus on average the cost of a fixed price contract will be higher than of an incentive or cost-plus contract. With the degree of technical risk common in defence contracts, over 50% of the bid on a fixed price contract can be for unspecified contingencies. In an optimal contract the fraction of costs reimbursed would rise with the firm's degree of risk aversion. Indexing the contract, setting  $\gamma = 1$ , removes one source of exogenous uncertainty for the firm. Further, fixed price contracts may not be credible if enforcement would drive a major defence contractor into bankruptcy. Bankruptcy means that the MOD does not get the weapons it needs, strategic capacity and a potential competitor are lost, and there is likely to be a political outcry. Ex post, bailing out the firm is likely to be optimal, and this will be anticipated, ex ante, by the firms making the bidding.

4.2.2 Moral hazard problems arise because costs and quality are endogenous resulting from the firms efforts, which the MOD cannot monitor. Cost-plus contracts, ( $\delta = 1$ ), give the firm less incentive to reduce costs. There will be some incentive: gross waste may be revealed by the auditing process, and the firm's resources have opportunity costs which encourages more efficient use; but it may not be very much. Under fixed price contracts, the firm has incentives to minimise costs. However, if the quality of the final product cannot be easily monitored (you only discover whether a missile works when you fire it in combat), the firm has incentives to cut costs by sacrificing quality under fixed price, where it has no such incentive under cost-plus.

4.2.3. Adverse selection can arise under competitive bidding because the MOD cannot discover certain information, private to the firm, and thus may select an inappropriate type of contractor. For instance, the lowest bidder may not be the lowest cost producer, but may merely be ignorant of the difficulties involved or may be trying to "buy-in" to



the project, believing that the MOD will compensate for the cost over-run once locked in. Thus the bidding has some characteristics of a common value auction, with the danger of a "winner's curse": the firm who most underestimates the actual cost, being either relatively ill-informed about the difficulty of the project or unlucky in its estimates, will win the contract. If, as a result, the MOD gets the product below cost it is merely a transfer from firm to MOD; but, given the bankruptcy constraint the MOD may be forced to bail out the inappropriate winner, an efficiency loss if the winner is a high cost producer relative to losers

4.2.4 Information rents can be extracted under fixed price contracts because monopolists, the norm in defence, who have private information about their costs can bid high and extract higher profits. Cost plus or incentive payments based on monitored costs can reduce this rent. Reichelstein and Osband (1984) characterise a class of payment schemes that induce contracting firms to share private information with the government. However, Laffont & Tirole (1986) show that, under suitable assumptions, inducing truthful revelation of this private information prevents attainment of the full optimum, since low cost firms require an information rent to induce truthful reporting. They derive optimal linear contracts under moral hazard by emphasizing adverse selection rather than risk aversion and considering cases where firms of different types self-select when signing the contract. But, as usual, the contract is not robust to variations in the specification of the problem.

4.2.5 Renegotiation is common because information about the threat and technology is constantly changing. Cancellation of the project is an extreme form of renegotiation. Contracts tend to be incomplete both because transactions costs make it expensive to allow for every eventuality and because some terms may be impossible to enforce if monitoring technology cannot reveal non-compliance. The terms of the original contract may be set strategically to give the parties leverage in bargaining over subsequent amendments. Of particular importance are design changes required in response to new technologies or threats. Whereas cost-plus contracts can accommodate these, fixed price

contracts are very inflexible and the inevitable changes have to be renegotiated at a stage in the process where the firm has great bargaining power and the MOD's threat of cancellation may not be credible. Even after competitive bidding, once the contract has been awarded, the relationship becomes one of bilateral monopoly because of sunk, relationship specific, investments. The length of military development, production and use cycles lock buyers into relationships with suppliers who will have a degree of monopoly over information, production facilities, and the spares and munitions essential to the operation of the system, which gives them power in renegotiation.

In conjunction, these features make formal analysis of the complete problem intractable, Barron & Besanko (1988). Most of the theoretical literature is concerned with examining cases exhibiting a sub-set of these features, though even here the optimal contracts are often complex and nonrobust. Even where there are clear theoretical results, they depend on assumptions about the precise form of the problem (e.g the exact specification of the cost and utility functions and stochastic process generating uncertainty), and it is difficult in reality to decide which assumptions are appropriate to a particular empirical case. For instance although increasing returns to scale and the learning curve make placing the project as a single contract attractive; under imperfect competition the production inefficiencies may be offset by the incentive effects of splitting it up into sequential contracts. In principle, a fractional purchase is more desirable when the interface efficiency loss in transferring production from one firm to another is small, and when the number of potential producers is small; in practice quantifying small is fraught with difficulty.

Given the uncertainties, moral hazards and large expenditures involved in defence procurement, there are temptations to construct elaborate, bureaucratic, "rational", decision making procedures. Economists have been articulate proponents of such systems, though it is not clear that they produce better decisions. Luttwak (1985) in advocating more "waste, fraud and mismanagement" in the Pentagon, argues that the formal systems over-emphasise quantitative aspects and ignore the important military



factors and replace criteria of combat effectiveness by considerations of business efficiency. McNaugher (1987) argues that under conditions of rapidly changing technology and environment, the best weapons projects are marked by unified authority, sharp trade-offs, and flexibility; characteristics formal systems are poorly equipped to provide. In procurement, the primary issue is not writing a contract, but designing a relationship.

#### 4.3 The procurement process.

The form of the relationship differs substantially within Europe. At one extreme is France where the procurement agency, Delegation General pour l'Armement, (DGA), has traditionally been a patron for a largely nationalised arms industry, thus internalising the principal-agent problems. At the other extreme is the recent British practice where the Procurement Executive sees itself as primarily as a commercial purchaser for the armed services, relying on the power of market forces.

The French emphasise the partnership between the powerful DGA and the arms producers. This partnership, or 'arms oligarchy' (Kolodziej 1987), is reinforced by movement of personnel between the DGA and the firms, both of which tend to be run by graduates of the Ecole Polytechnique. The DGA has an explicit role in the guidance (tutelle) of industry, thus weapons procurement and arms-export promotion are a part of a coherent industrial policy, developed over decades, in which the firms have considerable freedom to design and construct the weapons they think will sell on world markets. In international terms, the French armed services and politicians have had relatively little impact on conventional weapons decisions, being left as interested observers of DGA dirigisme. The collapse in export demand for arms and the increasing internationalisation of the European defence industry, have raised questions about the viability of this strategy.

Britain has adopted a more commercial, free market, approach. The nationalised arms producers were privatised and the Procurement Executive moved to competitive tendering for fixed price contracts, which were awarded on the basis of value for money even to foreign firms on a number of occasions. For instance the UK Nimrod



More generally, multi-lateral agreement has been slow. The Independent European Program Group conducted a major study on rationalising the European Defence Industry (IEPG 1987), and an "Action Plan" was approved in 1988. However, the compromise involved the large defence producers (France, Germany & the UK) promising to help build up the defence industries in the "Less Development Defence Industry" countries, such as Spain and Portugal. Had any actions been taken this would have worsened the problems of fragmentation and over-capacity that the agreement was designed to solve; in fact, virtually no actions were taken. At a different level IEPG has promoted a joint research programme EUCLID (European Cooperative Long-term Initiative for Defence) modelled on the EC EUREKA programme and encouraged reciprocal purchasing schemes like that operating between France and the UK.

1992 and the completion of the European market may also influence the process. Although EC powers with respect to military equipment seem limited by Article 223 of the Treaty of Rome, most of the arms companies also operate in the civil market and this will influence their adjustment. Under Article 30 of the Single European Act the Community has the responsibility to maintain the technological and industrial conditions necessary for security, which provides an entry for Commission involvement in the defence industry. US firms fear that 1992 and IEPG proposals might result in the extension of the EC Common External Tariff to weapons, but this seems unlikely.

While nothing in the current European negotiations offers hope of either a common market or a common procurement agency, a defence industry crisis could provoke rapid change, because the current plethora of national monopolies are not viable. If a common procurement agency was adopted, the basic question – should it be a patron implementing an industrial policy or merely a value for money purchaser for the military? – recurs, but at a European rather than a national level. Any such agency is likely to be given multiple conflicting objectives such as:

- providing good value weapons, of a design acceptable to the military which can be standardised and inter-operable through Europe;
- encouraging the rationalisation of R&D and of production capability, which is in excess of that required by demand and strategic capacity;

- maintaining competition, at least with the US, if not within Europe;
- promoting corporate structures that have the power to control costs, finances, and quality, and also the capacity to act entrepreneurially, characteristics lacking in the present European consortia.

While specifying objectives is easy, reconciling them is not. The arguments for some industrial policy are clear. There are externalities if technological spin-offs from defence are important; monopoly is prevalent therefore regulation is required; the MOD as an informed customer can take a longer term view than myopic market forces. The arguments for any particular industrial policy are less clear because we lack hard evidence on crucial parameters. Even if the agency could specify the industrial structure required, the policy would also have to be implemented by agreement between a large number of interacting countries within the agency, which is likely to suffer from the standard problems of international bureaucracies, particularly the danger of capture by the military and industrial interests. While a single common agency poses severe problems, there may be a case for competing joint agencies, with more specialised remits and limited lives to procure particular types of equipment. These would be a development of the agencies used to run existing collaborative consortia.

The alternative to a common agency is a common market, based on value for money procurement at a European level, making fixed price contracts and competitive tendering within an open European market the norm and using the threat of US imports to offset monopoly power where necessary. Specialised joint agencies for groups of countries procuring particular types of equipment would operate under the same rules. The "value for money" policy faces difficulties, of political feasibility, equity, enforcement and vulnerability to cheating but compared to a single common agency it is more transparent and robust. Transparency makes it easier to specify the objectives and negotiate the procedures. Robustness makes it less sensitive to uncertainty about crucial parameters such as civil-military synergies and less prone to capture.

#### 4.4 Defence Industrial structure.



The defence industry faces major problems, which are unlikely to be eased by the Gulf War. A French DGA official describes the position as follows. "There's probably 30% excess in production, too many competing players on the supply side, too many disagreeing members on the demand side, domestic markets closed to the tune of 90% or so, and maybe worse things to come: domestic armaments budgets are being reduced and disarmament will spur a technological race, increasing the need for R&D while decreasing production." (Philippe Roger, *Armed Forces Journal International*, January 1991 p33). The UK Monopolies and Mergers Commission describes the current trends in the industry as "falling demand and growing overcapacity; increasingly sophisticated and expensive technologies; breakdown of national markets and internationalisation of procurement through consortia" (MMC 1991). Reviews of the European defence industry are provided by Anthony et. al. (1990) and Hebert et. al. (1991).

This industrial crisis, which is likely to be a proximate cause of movement towards European security cooperation, is striking, because compared with other industries, the structure of the international defence industry was rather fixed until recently. It was largely dominated by monopolistic national champions, and reflected a stable equilibrium between the interests of the domestic incumbents and their governments. This equilibrium was disturbed by falling real defence budgets and falling demand for arms exports, which hit the French industry particularly badly, together with rising development costs. In combination, these put substantial pressure on the industry, which responded by a period of massive restructuring during 1988-90. Table 5 shows the main European defence firms in 1988. Since then, the position has changed rapidly. Particular examples include the formation of Deutsche Aerospace by Daimler Benz through the acquisition of MBB; the acquisition of Plessey by GEC & Siemens; the merging of Aerospatiale's avionics interests into Thomson CSF; the proposed Thomson-BAe merger of their missile interests; and the sale by Ferranti of a large part of its defence interests to GEC after it incurred an \$185 million loss as a result of suspected fraud by a recently acquired US subsidiary. Many smaller companies such as FN in Belgium and Heckler-Koch in Germany were taken over by foreign majors. The declining market and rapid concentration persuaded Philips, Racal & Thorn-EMI to

divest their defence subsidiaries. However, only Philips found buyers. The origins of the restructuring predated the end of the Cold War, but the events of 1989-90 reinforced a perception that the market will soon be divided into a core made up of a few large players and a periphery of specialist niche producers.

Below the super-structure of national champions there is a proliferation of international corporate links. These include extensive subcontracting, offset purchases, cross-holdings of shares (GEC and Daimler in Matra), research cooperation, joint ventures and the like, often including US as well as European companies. SNECMA the French aero-engine company has traditionally close links with General Electric, so Deutsche-Aerospace forged close links with Pratt & Whitney, the other large US engine producer. These strategic alliances threaten the largest European producer, Rolls Royce. Many joint ventures in defence production arose from collaboration, which creates links between firms as well as governments. These links may be productive enough to promote closer union, or unpleasant enough to inhibit further contact, as has happened in some Franco-British projects. Collaboration has also allowed fragmentation to persist, since political nomination of domestic producers and non-competitive work-share, kept certain firms independently viable, whereas in a more commercial market they would be vulnerable to acquisition by foreign majors. The complexities of collaboration may inhibit acquisition by making it more complicated. A may find it difficult to acquire or value B, when a large part of B's work is with a competitor of A.

In the past the creation of true Multinationals, which are typical of other industries, was obstructed by national governments and collaboration and the other types of joint venture acted as a substitute form of internationalisation. Whether they can continue to act as a substitute is unclear. The national champions are quite small relative to American competitors: in 1988 the combined arms sales of the 100 largest European companies was roughly the same as the combined arms sales of the ten largest US companies. In world terms BAe the largest European ranked 7th. The problem is that national procurement does not provide production runs long enough to reap economies of scale or spread the large fixed R&D costs. This problem will get worse with lower defence budgets and the escalating development costs of high-tech weapons. Thus



the economics of the industry may force an internationalist policy on governments, whatever their nationalist preferences. Were true European defence Multinationals to develop, it could reduce a lot of the political and administrative costs of collaboration, since they could organise the production on commercial grounds avoiding the politically acrimonious worksharing disputes. The collaborating governments would then need "only" to agree specifications and hold the competition through a joint agency.

European defence multinationals could come in many forms. They could be national companies with subsidiaries in other European countries, which happens on a small scale already. They could be true Transnationals of the Shell and Unilever type produced by merger. They could be multi-national subsidiaries of national companies, such as that proposed by BAe and Thomson, who had intended to merge their missile divisions under a Dutch holding company, Eurodynamics NL, in which they would have equal shares. They could be consortia for specific products like Airbus and Panavia, which makes Tornado. They could be ad hoc strategic groups in which an alliance of majors was linked to a collection of specialist subcontractors. Since, the circumstances, in particular the interaction with the civil markets, differ so much in the various sectors – aerospace, electronics, shipbuilding, armoured vehicles, software, etc – it is unlikely that a single type of structure will predominate. To the extent that the competitors for a procurement contract are multi-national, political pressures for protection and inefficient work-sharing arrangements may be reduced.

Walker & Gummett (1989) discuss the evolution of a European market for weapons in more detail, emphasising "that various factors are tending to place greater market power in the hands of the large European defence contractors – which are acting increasingly in concert with each other – without any assurance that economies of scale or other economic benefits will result". They also point out the danger that the creation of European monopolies will reduce choice and flexibility. However, the degree of competition between European producers is already rather small. Currently, the alternative to domestic production or collaboration for most European countries is usually to import from the US, rather than from another European country, and that possibility will remain. Whether the threat of import from the US carries political

credibility is another matter, particularly since it will be argued that only by supporting European companies can US monopoly pricing be prevented.

## 5. Wider policy issues.

This section examines three general policy questions that an EDU raises. Would the infringement of national sovereignty involved be acceptable? How would an EDU be paid for? How robust would it be to exploitation by military-industrial interests? To provide some context the first section considers alternative routes towards the institutional design of an EDU.

### 5.1 Institutional Design.

Institutional design, constructing the rules of the game for the EDU, is likely to be central. It is important to distinguish institutions from organisations. Institutions are the constraints that structure interaction, whether informal norms or formal rules like laws of contract or rules of the sea, within which organisations evolve. Institutions are characterised by increasing returns to scale, they raise the benefits of cooperation and cut the costs of transactions, making it exploit gains from trade. For instance, the initial investment by Navies in establishing standard operating procedures, generates a continuing stream of benefits in terms of greater freedom of manoeuvre and reduced risk of collision. North (1991) provides a survey of institutions, for the economy as a whole rather than the military but the general principles are the same. He comments "It has commonly been the case that the incentive structure provided by the basic institutional framework creates opportunities for the consequent organisations to evolve, but the direction of their development has not been to promote productivity raising activities. Rather private profitability has been enhanced by creating monopolies, by restricting entry and factor mobility, and by political organisations that established property rights that redistributed rather than increased income." The EDU problem is to establish an institutional framework that will provide incentives for the evolution of productivity



enhancing rather than rent-seeking organisations.

Given political will, there would be little technical difficulty in establishing organisations such as a unified military command structure, based on the wealth of experience from NATO or centralised procurement agencies, using standard operating procedures that have been developed for collaborative projects. Among the European military, cooperation is already highly institutionalised. But this is like saying given wings pigs would fly: designing the political wings is the difficulty. The lack of political institutions means that it is neither desirable nor possible to provide a detailed blueprint for organisation at the moment. It is not possible because the differences in domestic political structures, international orientation and military organisation even within the WEU countries would preclude agreement. It is not desirable, because effective organisations are more likely to evolve from the development of rules through experience in cooperation than from specifications laid down in advance. It is also likely that the speed of evolution will be faster if there are competing organisations, e.g. multiple procurement agencies, multiple multilateral forces for different purposes, e.g. naval, rapid deployment, early warning. Evaluation of comparative performance would aid learning.

This would suggest building on existing plans and arrangements, but trying to get them to point in the same direction. Any guess about the organisational outcome is inevitably speculative. It could involve most forces being under national command in peacetime, but participating in an extended integrated military command, on NATO lines, which would come into operation in the case of war. The growth in political authority and institutional impact of the WEU, acting as the security arm of the EC, might allow it to dominate the NATO Council and inherit NATO structures. France and Spain might join the new integrated military command in which the US has a much more marginal role. The range of multinational specialised forces, such as AWACS and Mobile Forces, and infrastructure projects would be extended. There could be more symmetrical foreign stationing of national units, i.e. German forces in France as well as French forces in Germany, and more division of labour in which countries specialise in certain roles. There would be more coordination of procurement at a European level. Existing EC rules on open sourcing of public procurement could be extended to the





defence market, and specialised central procurement agencies, like the existing ones for Tornado and EFA, would become established for wider categories of systems, such as helicopters and armored vehicles. Conflicts over whether contracts should be awarded competitively on the basis of value for money, rather than the present political work-sharing (*juste retour*) would need to be resolved. Changes in procurement and organisation would cause a further restructuring of the defence market, probably producing multi-national European companies, in whose interest it would be to encourage standardisation. If the efficiency gains were realised, and the problems resolved, there would be strong incentives for countries to extend these initiatives, reinforcing common structures and promoting common institutions, thus encouraging the growth of a cohesive EDU.

Such evolutionary scenarios leave unspecified how decisions about the use of these forces would be made. The difference in interests among the WEU members may be small, but the difference in attitudes to the use of force is great. France and Britain have used their troops abroad repeatedly, the other members, after decolonisation, have not. The attitudes may, of course, merely reflect opportunities: their lack of ability to project force. The possession of capable, mobile intervention forces might then tempt Europe into foreign adventures, that it might regret. These issues go beyond the economics towards issues of sovereignty.

## 5.2 Common interests and sovereignty.

Suppose the EDU did manage to produce common European forces which packed more military punch at less cost, by rationalising procurement, concentrating forces, and providing large indivisible systems. These forces would be of little use unless there were common European interests they could defend. If the point of the forces is to defend national interests and national sovereignty, common European forces are of little value. Issues of sovereignty and commonality of European national interests are thus central. The extent of the loss of sovereignty would depend, of course, on the proportion of the forces that remain under national control.

The traditional idea of sovereignty, that the state is the supreme authority

within a territory and not subject to any authority above it, although seriously undermined by international economic and political interdependence. In the defence context, sovereignty has instrumental, decision-making, and symbolic functions. Armed forces are needed as an instrument of the authority of the state, it cannot rely on others to make decisions about its interests, and the armed forces symbolise the state.

5.2.1 The instrumental function of sovereignty arises because a state needs armed forces to defend its interests and maintain its authority. Not all forces would be pooled, states would retain some to deal with specific national commitments such as the UK's war in Northern Ireland. But in terms of external relations European nations have fewer vital yet unique national interests than in the past where they had specific national entanglements through colonies etc. To the extent that the vital interests of European states tend to be common ones (protection of oil supplies and foreign assets) a collective response, met by pooled forces, is more effective. The status quo is not necessarily the right standard of comparison, since it is likely that rising costs, advancing technologies and declining defence budgets mean that individual national states would have to surrender instrumental capabilities that they now consider central to their sovereignty anyway. But even if the EDU results in a net improvement in options, capabilities are increased relative to the national alternative, the decision to use those capabilities will be joint rather than individual, thus appearing as a reduction in the degree of freedom and autonomy available to the state. Relative to dependence on the US, with very little input into US decision making, having a larger say in the use of a European capability may represent an increase in sovereignty. Nor is it clear that any loss of sovereignty arising from more extensive multi-national forces is necessarily bad. The military division of labour, by binding the participants into a position of mutual dependence, may reduce the risk of antagonism between them. While fear of war within the EC seems rare, the only disputed territory is Gibraltar, fear about the military position of unified Germany is more common. A Defence Union might reassure Germany's neighbours, who worry simultaneously about the dangers of German belligerence and of German neutrality.



5.2.2 The decision making function of sovereignty is that in times of crisis only the national state can make the decision to go to war. This right would be abrogated by collective forces under joint command. States partly surrender that right already through treaty obligations and their commitments to the NATO integrated command. To the extent that they insist on the right to make individual decisions in circumstances of crisis they weaken the deterrence provided by the alliance, and they suffer from that weakening. Ex ante commitment is the cost which produces the deterrence and defence benefits which arise from the concentration of forces and command. Collective forces make that commitment more credible.

However, to be credible, collective forces need unified decision making, clear command and control that permits rapid action. Within NATO and the Gulf operation, this arose from American hegemony. Likewise the European Monetary System works because of German Hegemony. Within a European Defence Union, there would be no national hegemony, no one country yet dominates. The consequence of this could be the shifting coalitions, stalemate and indecision that often characterise international organisations. Command and control has two aspects: military organisation and political authority. Establishing a unified military organisation for multi-national forces seems possible as long as the multi-lateral military had the same independence in appointment, promotion and disciplinary action as European national military forces have at present. Similar arguments apply to procurement agencies. National agencies have some autonomy from domestic politics, multinational ones tend to have less. Relative independence from domestic politics for procurement agencies and military commanders is essential. Detailed legislative involvement in military budgeting and procurement, of the sort practiced by the US Congress, creates a range of inefficiencies and encourages rent-seeking. This is discussed further below.

While clear political control at the top is essential, it seems impossible at the moment. While there may be advantages in delegating Monetary Policy to an independent Chairman of a European Central Bank, there is no way that European Security Policy, decisions about mobilisation, deployment and war, could be delegated to an independent Chairman of the European Joint Chiefs of Staff. Even if national

authorities were willing to share their decision-making authority, an institutional mechanism for taking shared decisions is needed.

5.2.3 The symbolic function of the armed forces is to represent the state and its conception of itself. Ceremonial guards in their traditional costumes could certainly be maintained in each country at little cost, more important is the link between the armed forces, where morale and other psychological factors are central, and the polity. The military planners central problem is how to persuade large numbers of people to get themselves killed, persuading them to kill is usually less difficult. Since being willing to get oneself killed is individually irrational in the usual cost-benefit terms, it tends to be supported by institutions, like regimental traditions and nationalism, which appear individually irrational to economists. Many such traditions would be overturned in forming an EDU and may provoke a political outcry. Within the armed forces themselves, if the initial multi-national forces are elite units, e.g. for rapid deployment, there would be a strong incentive to serve in them, particularly if multi-national service became a pre-condition for promotion. The argument that people would be less willing to fight for a European army than a national army seems implausible, most wars are fought for coalitions. Nor are the present non-national formations in European armies, such as the Foreign Legions and the Ghurkas, known for their lack of commitment.

Economic and social interdependence and the changing strategic environment complicate assessments of sovereignty. In some situations, a country or alliance can see a clear threat to identifiable interests. This provides a basis for calculating the appropriate level and organisation of its military preparations. In other situations, its interests are diffuse and threats are unpredictable. This provides little more than a basis for having some general purpose forces, just in case something happens. For instance, the Swiss have always had difficulty in providing a specific scenario in which their armed forces might be used, nonetheless they have maintained an effective military machine based on mass mobilisation. With the end of the Cold War, Europe seems to be moving from the first to the second situation, and individual countries may be more reassured by a share in a capable European force than sovereignty over an expensive but inadequate national





force. But even if was reassuring, there would be a temptation to free-ride and try to avoid paying for it.

### 5.3 Contributions.

Contribution arrangements could start from existing procedures which are already used extensively for the NATO infrastructure fund, multinational forces and collaborative procurement projects. While the details of each of these are complicated the principle is simple. There are already a number of central agencies with national representatives which agree joint needs, production (constructing airfields, building planes, providing forces to multi-national units), and contributions. Individual national governments take responsibility for the various parts of production, and imbalances between production costs and assessed contributions are dealt with by side-payments between them. The central agency keeps the accounts, but does not tax or handle money. This system of voluntary side-payments is a quite different model from that of the EC, which has own resources coming from compulsory contributions. For instance, the DM800m contribution by Germany to the towards the UK's Gulf costs for the first quarter of 1991, can be interpreted within this side-payments model.

Some national discretion on contribution provide constraints and maintains control over the international bureaucracy. Thus the evolutionary scenario in section 5.1 could be based on a patchwork of contribution methods based on existing arrangements, which allowed for the heterogeneity of needs and functions. Providing the staffing for an integrated command would not be very expensive; individual countries would contribute troops and equipment to multi-national units; and there would be contributions to infrastructure projects, joint procurement, R&D and the like based on benefits. This structure depends on national willingness to contribute and not to free ride. The evidence on the likelihood of free riding is mixed.

Within NATO "Burden sharing", as the contribution issue has been known, has been a recurrent source of acrimony, surfacing recently with respect to the Gulf War. There is a large analytical and empirical literature on the subject. The starting point was the assumption that spending on the defence of Europe to deter the Soviet Union was



a public good, conferring collective benefit, even though it was provided privately by individual nations. Olson & Zeckhauser (1966) suggested that since it was in the strategic interest of the US to provide for the defence of Europe, smaller allies had an incentive to free ride. Assuming that the benefit that a country got from its defence spending was proportional to its GDP, this gave the empirical prediction that defence spending as a proportion of GDP would rise with total GDP among NATO nations. Data for the 1950s and 60s appeared broadly consistent with this hypothesis, but subsequent evidence for it is much weaker. As the results in the appendix show, there is a positive association of the share of military expenditure with population as would be expected from the standard public good argument.

There are obvious extensions to this explanation, which have been intensively explored. A variety of special cases of this structure have been analysed in the literature and used as the basis of econometric estimation of the determination of NATO defence spending. Of particular interest, McGuire and Groth (1985) show that for a model of this sort it is, in principle, possible to determine whether a Cournot or Lindahl allocation process is operating. In practice, of course, econometric estimates conflict. For instance, although it depends on the precise specification of the model, under Cournot behaviour one might expect a negative association between the military expenditures of allies, the others compensate for any change, while under Lindahl behaviour a positive association, since all adjust their expenditure shares together. Smith (1980) and Murdoch & Sandler (1984) obtain negative responses, but Smith (1989) argues that these result from dynamic misspecification and once this is corrected the estimated response is positive. Of course, even with Cournot behaviour a positive association may be observed, since if the threat changes all the allies expenditures will move in the same direction. Some of these models allow for measures of the threat, but available measures such as estimates of Soviet military expenditure may not be good proxies.

Murdoch and Sandler (1990) use NATO time-series data to test between Cournot and Lindahl behaviour. They reject the Lindahl process for all 10 countries examined but also reject Cournot for the five largest countries (US, Canada, UK, France & Germany). They conclude that "there is evidence that defence allocations are Pareto

sub-optimal in the NATO alliance<sup>20</sup>. However, their model does not allow for any dynamics or differential cost structures such as conscription, and aggregates US and other NATO expenditures together as an explanatory variable.

Given the asymmetric structure of the alliance, spending by different countries will spillover differently, and be responded to differently. One possibility is a Lindahl equilibrium among European states, conditional on US spending. Evidence for this is that the association between the share of military expenditure is much weaker within the WEU than within the whole sample. The small size of the group and the importance of defence encourage strategic interaction and explicit bargaining, e.g. Oneal (1990). There is much less heterogeneity within the WEU than within NATO and the variance of defence burdens is comparatively small within the core European states. Oneal's results suggest that defence burdens seem to respond positively to proxies for European interdependence. The tax rates, i.e. the shares of the joint forces each country provides in the Lindahl equilibrium could be determined in a number of ways. For instance, the demand functions may reflect considerations of equity so equality of defence burden (military expenditure as a share of GDP) may not be an appropriate standard, because it reflects neither the resource cost of conscription nor countries ability to pay, which would be related to per capita GDP rather than total GDP.

To accept behaviour as Cournot, within Europe, means accepting that there was under-provision of defence; substantial underprovision if one accepted the estimates given in section 2.3. While any judgement of how much defence is enough must be subjective, there seems very little evidence of serious underprovision, by the usual criteria. It should also be noted that under Cournot allocation when costs differ, one may get under provision, but over-spending, if the allocation results in high cost producers providing. This might have been the case in NATO where the US, a high cost producer, provided too much. The main point is that the benefits of an EDU would have to arise not primarily from ending sub-optimal provision of a public good produced privately, but from improvements in the efficiency which result from the collective production and use of the public good.

The alternatives are an EDU financed by a system of voluntary side-payments



or an EDU with its own-resources derived from a system of taxes on countries to provide centrally organised military services. Side-payments suffer the problem of free-riding, but the voluntary character constrains the possibility of unrestricted budget expansion. Within countries, Finance Ministries provide a countervailing power to budget expansion, a similar countervailing power would be needed at the EDU. As yet international organisations have not found an appropriate way to construct such a countervailing power, hence the preference for a voluntary system. This raises more general regulatory problems.

#### 5.4 Regulatory structure.

In order to realise any potential efficiency gains it would be important to ensure that the structure does not create new powerful pressure groups with incentives to invest in directly unproductive profit seeking activities offered by the EDU, nor reduce the freedom of action of the nations involved to remedy misallocations. The defining character of a state is usually taken as its monopoly of the legitimate use of violence, usually sub-contracted to the armed forces. Monopolies imply rents, and there are incentives to invest resources in acquiring those rents. Figure 5 provides the familiar picture, DD is the demand curve, pm is the monopoly price and pc the competitive price. Suppose that agents expenditure on obtaining or maintaining the monopoly profit is equal to the monopoly profit, ABDE, (this will happen if acquiring monopolies is a competitive activity) and suppose also that this expenditure is socially wasteful lobbying and the like; then the efficiency loss associated with the monopoly is not the usual deadweight loss triangle, BDE, but the whole area ABCD.

This theory of monopoly pricing and monopoly seeking activity applies very obviously to the efforts of arms firms to acquire and exploit procurement contracts, as was seen in section 4. The large defence contractors have great lobbying power. Market Access (1989) describes their efforts in a number of cases. Because of the special status of defence, their claims about employment consequences, technological spin-off, export prospects and national prestige have created non-tariff barriers which enable them to win procurement contests against lower cost foreign competition. Such arguments carry less

weight in others industries and are not substantiated by experience, but tend to be politically effective in defence. Their lobbying power may also allow the defence industries to "capture" any European industrial policy and to direct it in their own interest. However, although substantial, expenditure on lobbying in Europe is much less than in the US, primarily because European Parliaments have much less influence on individual decisions than does the US Congress which decides on line items of the Budget. Pork-barrel lobbying carries more weight with elected representatives. Gansler (1989) compares the US and European models of budgeting and procurement, and argues strongly for an independent centralised acquisitions agency.

The monopoly argument also applies to the armed services because they are monopoly suppliers of a product, specialised forces to meet security interests, at a price, their budget. Their preferences will not match general social preferences, and their profit is money they divert to meeting their own interests rather than national, or European, interests. The preference for higher than optimal quality equipment discussed earlier is an example. The output they produce is difficult to measure and there are obvious limits to competition in this field, so there is a standard problem in regulation. The military have specialised private information, since only they have the detailed knowledge about the form of the likely threat and the optimal form of response, and can extract some information rent on the basis of this. They also have incentives to tailor this information in their own interests. The scope for special pleading and rent seeking is enhanced by the fundamental unresolvable uncertainty inherent in peace-time planning. Whether weapon, tactic, strategy A is better than B can only be judged in combat, any other judgement is inherently speculative. In the absence of combat experience, wrong decisions/procedures, like the Maginot Line, can persist for a long time.

Most of the rent-seeking arises from directly efforts to increase budgets and from inter-service rivalry for the monopoly of military roles, on both of which large amount of resources are expended unproductively to protect prerogatives and expand empires. An example which is unexceptional except for the length of the battle, was a dispute between the Italian air force and navy. A law of 1926 drafted by Mussolini and the Air Force Marshall Italo Balbo gave the air force exclusive aviation rights, despite



the fact that Italian military aviation had been pioneered by a naval officer, Lt Mario Calderara. Despite the military damage suffered during World War II as a result of the lack of an aircraft carrier capability, the air force monopoly on fixed wing aircraft was maintained. In the 1950s the US navy did give its Italian counterpart some jets, but the naval pilots who flew them onto Italian home soil were arrested and air force officials seized and mothballed the planes. Over the next three decades the two services devoted large amounts of manpower and resources to lobbying Parliament and campaigning in the press on the subject. The navy did acquire an aircraft carrier, the Guiseppe Garibaldi, despite being unable to put any aircraft on it. Eventually in 1989 a new law was passed authorising deployment of fixed wing aircraft on the carrier, subject to some convoluted compromises by which air force prerogatives were retained. (See Brendan Murphy, *Armed Forces Journal International* March 1989, p44).

There is a further aspect of the monopoly of force that has regulatory implications. Internationally the most common method of changing government has been by military coup; Greece, Turkey, Spain and Portugal have had recent experience of military government; and there has been concern about the dangers of military intervention in other European countries, including France in the late 1950s. Although fears of European military coups might seem fanciful, that is partly because many current institutions are designed to prevent that danger. For instance, conscription is seen as making a coup less likely. Were there the possibility of a European Government that the European military might take over, it would be a matter for thought.

Of more immediate relevance, the large amounts of money involved in military programmes, currently \$150 bn in the WEU as a whole; the proven power of national military-industrial complexes to appropriate that money for their own purposes; and the evident difficulty of international organisations, like the EC, in controlling particular forms of spending; all indicate that a precondition for a cost-effective EDU is an appropriate regulatory structure. That structure must involve: democratic but decisive high level political control over broad policy issues; relatively autonomous armed forces and procurement agencies not subject to low level political pressures; and a countervailing power that is at least as strong as national Finance Ministries.

## 6. Conclusion.

The current review of NATO strategy, the increasing activity of the WEU and the considerable EC interest in security coordination all seem likely to keep European military cooperation on the political agenda because. Against this background national defence provision will appear increasingly problematic because of budgetary pressures, rising costs and changing threats. The alternatives to European cooperation will then appear as either massive investment in defence at a time of falling threat, complete dependence on the US, or effective neutrality enforced by structural disarmament. The cost of dependence or neutrality would depend on whether Europe was threatened, by whom and the extent to which the US would act in Europe's interest. Given that Western Europe is surrounded by a zone of political instability, it is possible that threats to European interests may arise where it is not in the US interest to intervene. There are the costs of autarchy in defence and a customs union has attractions. The danger of the customs union is that the gains from trade-creation in closer defence ties between the European countries are balanced by trade diversion if US ties are weakened.

Gains from trade in military organisation arise because there are economies of scale in integration, since unified command can avoid duplication of support costs and fragmentation of forces. As a result, an EDU could realise large efficiency improvements and allow a more effective European defence. For example, instead of seven under-equipped and relatively immobile rapid deployment forces, Europe as a whole could, for less money, field a much more capable single force. There are further gains from common procurement because of the large fixed R&D costs and learning curve effects associated with weapons.

While there are gains to trade, there are also barriers to trade arising from divergences in perceptions of national interest, military traditions and patterns of domestic politics. In the short run these barriers are functional in that they preclude the establishment of counter-productive organisational forms: the equivalent of foreign trade monopolies. But these barriers are likely to be eroded by the evolution of voluntary military cooperation, building on existing institutions, and the emergence of multi-national defence companies. While this evolution should be encouraged, it will



require considerable institutional innovation to ensure that the potential gains from rationalisation are not wasted; the transactions costs involved in decision making are minimised; and the serious agency problems such as capture by the military industrial complex are minimised. These are the central economic issues.





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## Appendix.

### Lanchester Models.

Lepingwell (1987) provides an exposition and critical evaluation of the Lanchester model. Imagine two tank forces of sizes  $F_i$  and  $F_j$ , each able to aim fire and shift to a new target. The capability of the tanks determines the attrition rates,  $a_i$  &  $a_j$ , which are the product of the probability of a kill and the rate at which each can fire. The battle then evolves according to:

$$dF(t)_i/dt = -a_j F(t)_j \text{ and } dF(t)_j/dt = -a_i F(t)_i.$$

Solving these equations to give the level of forces so that the sides were equally matched gives:

$$a_i F^2(t)_i = a_j F^2(t)_j.$$

In a stochastic model, solution of the equations gives the ex ante odds on winning, a measure of security as:

$$S = \frac{a_i}{a_j} \left( \frac{F_i}{F_j} \right)^2$$

This model suggests that it is the square of the relative force size that matters.

### Testing Cournot against Lindahl allocations.

To illustrate the procedure for distinguishing the allocations, suppose all forces are public and there is a Cobb-Douglas welfare function for country i

$$W_i = (EF_i - \gamma T)^{\alpha} C_i^{(1-\alpha)},$$

budget constraint



$$Y_i = C_i + p_i F_i$$

where  $p$  is the price of forces, and  $M_i$  expenditure on the military. Under Cournot behaviour maximisation is done taking the Forces of the others as given producing a demand function:

$$M_i = p_i F_i = \alpha_i Y_i + (\alpha_i - 1) p_i \sum_{j \neq i} F_j + (1 - \alpha_i) \gamma_i p_i T.$$

With the same Welfare function, under Lindahl behaviour, the country takes  $\Sigma F$  as the choice variable, with a budget constraint:

$$Y_i = C_i + \tau_i \Sigma F$$

where  $\tau_i$  is the share of total military expenditure incurred by country  $i$ ; then assuming all  $p_i = 1$ , then in the Lindahl equilibrium, the demand function is

$$M_i = \tau_i \Sigma F = \alpha_i Y_i + (1 - \alpha_i) \gamma_i \tau_i T.$$

Econometric methods can in principle then be used to determine which function explains the observed data on military expenditure better.

#### Cross Section Patterns.

To illustrate possible magnitude of the effects consider some back of the envelope regressions on the cross-section data in table 2. The demand function in section 2.4 took the form:

$$M = F(Y, N, P, T_1, T_0)$$

If we assume that the income elasticity of demand for military expenditure is unity, and that in cross section countries face the same threat and price of military expenditure, this implies that the share of military spending should be related to population. A cross-section regression on the data in Table w indicated that NATO countries tended to spend more, and that Greece was a large outlier. Allowing for this by dummy variables, give a result:

$$M/Y = 1.45 + 0.01313 N + 1.02 \text{ NATO} + 3.19 \text{ GREECE}$$

(3.8)    (4.4)            (2.3)            (4.6)

(t ratios given in parentheses).

$R^2 = 0.75$ ; SER = 0.66; Tests statistics for: Functional form 0.07 (1); Normality 1.06

(2); Heteroskedasticity 1.91 (1). The test statistics are distributed as  $\chi^2$  with the degrees

of freedom given in parentheses. When GDP and a dummy for the United States are added to the regression they both have t statistics less than unity and  $F(2,11) = 0.21$ . Without the dummies, the coefficient and t ratio of population, N were 0.01325 (2.75); in the sample excluding the US and Canada, 0.01301 (0.99); and for the WEU countries alone 0.0105 (1.0).

To examine the effect of conscription, we follow the model in Fontanel, Humm & Smith (1987) and assume that military output, measured by expenditure, is generated by a CES production function of labour, number in the armed services, and other inputs. With non constant returns to scale the marginal productivity condition can be written:

$$m - f = \alpha + \sigma(w-p) + \beta m$$

where m is the log of military spending, f the log of the number in the armed forces, (w-p) is the real military wage,  $\sigma$  is the elasticity of substitution and  $\beta = \rho\sigma(1-1/v)$ , where  $\sigma = 1/(1+\rho)$  and v is the returns to scale parameter. If we assume that the real military wage is a function of per capita income (y-n) and the proportion of regulars among the forces, r,:

$$w-p = \gamma(y-n) + \delta r$$

Then we can rewrite the equation:

$$f = -\alpha - \sigma\gamma(y-n) - \sigma\delta r + (1-\beta)m$$

The estimates for this are:

$$f = 5.10 - 0.81(y-n) - 0.31 r + 0.87 m$$

(16.2) (7.9)                      (2.5)      (21.5)

(absolute values of t ratios in parentheses).

$$\bar{R}^2 = 0.97; \text{ SER} = 0.24.$$

Tests statistics for: Functional form 1.97 (1); Normality 0.46 (2); Heteroskedasticity 2.37

(1). The structural parameters are not identified, but if we assumed  $\gamma=1$ , this would imply an elasticity of substitution of 0.81, which is not implausible, and substantial increasing returns to scale.

Table 1.

Percentage responding Confident to the question

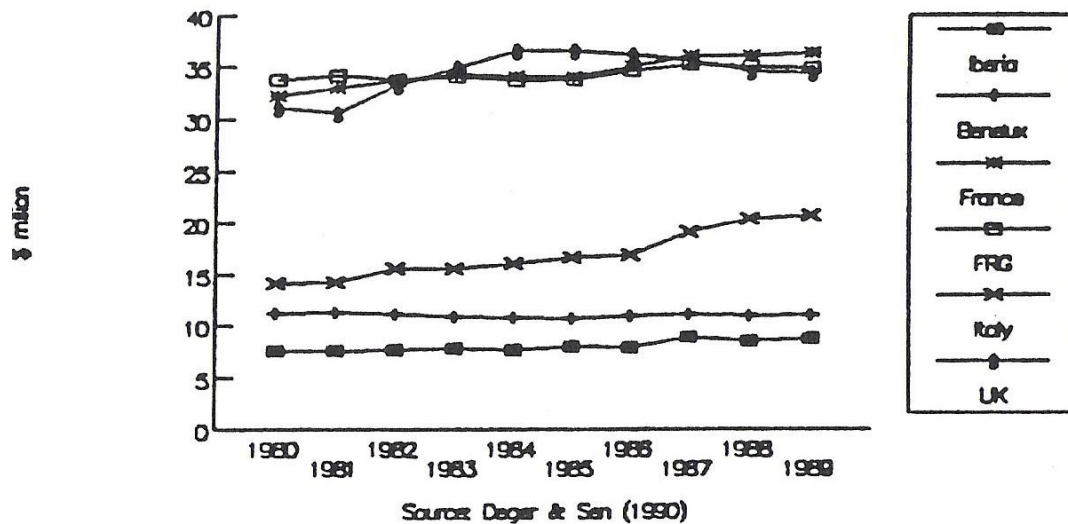
"For the following countries, how confident are you that it would engage its military forces if the Soviet Union were to invade your country."

	French	British	FGR	Italians
France	—	44	60	36
UK	67	—	55	33
W. Germany	60	51	—	31
Italy	45	30	37	—
US	71	78	70	71

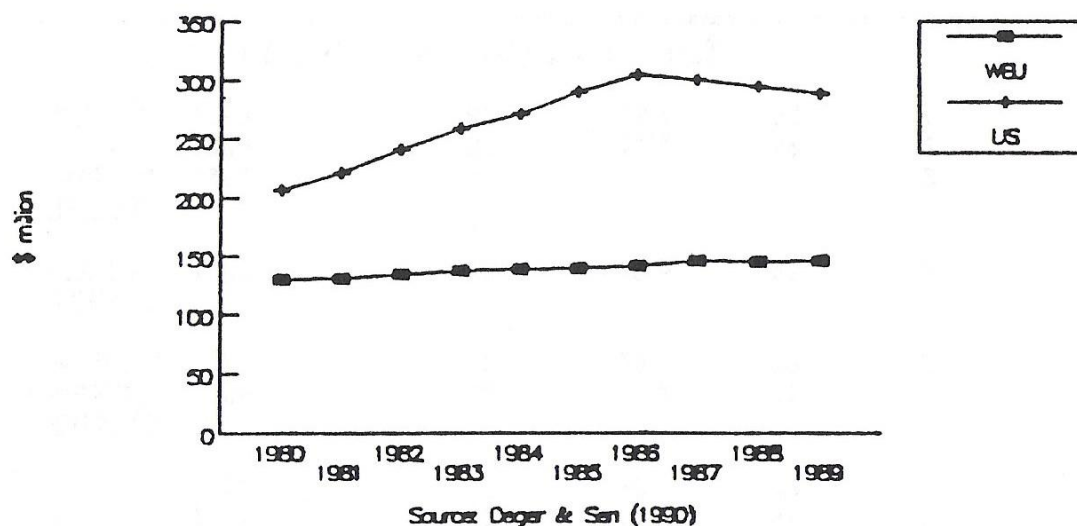
Source Armed Forces International September 1989, p 24



## WEU Countries Military Spending 1988 prices and exchange rate



## WEU and US Military Spending 1988 prices and exchange rate



**Table 4. Top arms producing Companies in Western Europe 1988.**  
**NOTE the position has changed substantially in the last three yea**

Rank	Company	Country	Arms Sales \$ millions
1	British Aerospace	UK	5470
2	Thomson	Fr	4470
3	GEC	UK	4320
4	Daimler Benz	FRG	3420
5	Rolls Royce	UK	2500
6	Aerospatiale	Fr	2300
7	DCN	Fr	2210
8	IRI	It	2100
9	Dassault	Fr	2080
10	MBB	FRG	1990
11	Lucas	UK	1760
12	EFIM	It	1520
13	Fiat	It	1500
14	INI	Sp	1290
15	Thorn EMI	UK	1200
16	Ferranti	UK	1170
17	GIAT	Fr	1150
18	Matra	Fr	1040
19	Philips	Neth	1010
20	Oerlikon	Switz	930
21	Nobel Industrier	Sweden	910
22	Plessey	UK	880
23	VSEL	UK	830
24	Siemens	FRG	800
25	SNECMA	Fr	770

Source, Anthony et al 1990.