

## **Full Report of Research Activities and Results**

### **Objectives**

The main aims of the research were to undertake a set of tightly linked theoretical and empirical investigations into:

- The relationship between military expenditure, investment behaviour and economic growth in OECD, small industrialising and developing economies.
- How the global defence industry has been restructured and the implications of these changes for procurement policy.

Specific research objectives are:

- To jointly study the determinants of military expenditure, investment behaviour and economic growth by estimating a simultaneous demand for military expenditure and growth system using large panels of data drawn from these groups of countries.
- To investigate the restructuring of the global defence industry and how this has affected the procurement process, by analysing the growth and survival of 100 largest arms producers and the changing nature of the procurement process, using annual SIPRI data.
- To develop, in relation to the previous objective, how procurement policy and the regulation of arms exports in the main arms exporter countries can be conducted when cost and market conditions are increasingly less visible to governments.

These aims have been fully met by the project. In particular, objective 1 is addressed principally by Dunne, Smith and Willenbockel (2004), Dunne and Smith (2004), Dunne, Nikolaidou and Smith (2002), and Dunne, Freeman and Soydan (2004a, 2004b); objective 2 by Dunne, Garcia-Alonso, Levine and Smith, henceforth DGLS (2004a, 2004b), and Dunne and Macdonald(2002, 2003); objective 3 also by DGLS (2004a) and by Garcia-Alonso and Levine (2003), Garcia-Alonso, Levine and Morga (2003), and Dunne and Perlo Freeman (2003c, 2003d).

In places our research has taken us beyond the remit of the project partly from the internal momentum of the research itself and partly in response to events and those following September 11<sup>th</sup> in particular. In the former category Garcia-Alonso and Levine (2004) generalizes the model of market structure in the global arms industry reported in DGLS (2004a) to any industry in which governments use procurement to influence market structure. Garcia-Alonso, Levine and Morga (2003) studies an arrangement associated with arms offsets in the form of export insurance coverage. Brauer and Dunne (2004a, 2004b) and Dunne and Lamb (2004) make more general contributions to this literature. In response to September 11<sup>th</sup>, DGLS (2004c) presents a simple model that captures some of the issues involved in managing asymmetric conflict. Full details of the results from these papers and how they relate to these objectives are provided below in the results section.

## **Methods**

In our theoretical work we pursued a methodology used in our previous ESRC-financed project of constructing partial equilibrium models linking supply and demand in the international market for military goods and providing results in the form of analytical results where possible and simulation results on a calibrated model otherwise. Our empirical work used standard econometric panel data and other techniques. In our estimation of simultaneous demand for military expenditure and growth Dunne and Smith (2004) reviews some difficult identification issues and discuss econometric methods for panels. Econometric issues for analyzing the growth of companies within a framework of testing Gibrat's Law is discussed in DGLS (2004b).

## **Results**

### **Objective 1: to jointly study the determinants of military expenditure, investment behaviour and economic growth**

Dunne, Smith and Willenbockel (2004) provides a contribution to the military expenditure-growth debate, with a comprehensive critique of the main growth model used in such studies, the Feder Ram model. It outlines the model's theoretical and empirical limitations and develops this model to explicitly deal with a panel of data. It concludes with some interesting results for 28 countries, with military spending having a negative impact on the long run steady state growth path. Dunne and Smith (2004) uses the same data set to analyse the relationship between military spending, investment and economic growth. It briefly reviews the economic theory, emphasising the difficult identification issues involved in determining the interaction between military expenditure and output and discusses econometric methods for panels. Then it provides estimates of various models examining the interaction between the three variables. The data do not suggest any strong relations between military expenditure and either investment or growth. This is not unexpected given the theoretical and econometric problems involved. In a similar vein, Dunne, Nikolaidou and Smith (2002) analyses a panel of small industrialised economies, estimating a growth equation and an investment equation, where investment is a function of growth and military expenditure. The data is used to consider the individual economies and to provide some panel time-series results. The results show that for the small industrialised economies there is some evidence of a negative impact of military spending on growth and investment.

Other work has dealt with other possible indirect effects of military spending on growth. Dunne, Freeman and Soydan (2004a, 2004b) consider the impact of military spending on debt; the first of these papers examines a panel of 11 small industrialising economies and provides estimates for fixed effects and random effects models and then moves on to consider dynamic models. The dynamics are found to be important and the results suggest that military burden does indeed have a positive impact on the share of external debt in GDP.

It is important not only to consider cross-country information, but also to investigate the dynamics of particular countries. Dunne, Freeman and Soydan (2004b) provides such an analysis for Argentina, Brazil and Chile. These countries were chosen as the

debt crisis that struck South American countries in the 1980s led to severe recession and chronic economic problems and there has been considerable variation in these countries' military expenditures. The paper finds no evidence that military burden had any impact on the evolution of debt in Argentina and Brazil, but some evidence that military burden tended to increase debt in Chile. At the same time Chile was the least affected of the three countries by acute financial crises resulting from the debt problems, although their relative levels of debt were as high or higher. This suggests that military burden may be important in determining debt in countries, but it is only of significance when it is not swamped by other macroeconomic and international factors.

Other work in progress, Dunne and Watson (2004) undertakes an empirical analysis of the employment effects of military expenditure in Western Europe. Estimating country-specific labour demand models leads to the conclusion that there are considerable differences in the estimated impact of military expenditure on employment. This leads to the hypothesis that such findings are due to changes in the nature of arms production and can only be understood through further examination of the link between military expenditure and technological progress. Constructing a panel data set covering the main European arms producers and the emerging arms industries allows an investigation of whether, or not, technological "spin-offs" from the arms production sector have led to changes in employment. Other contributions include Dunne and Birdi (2002) and Dunne and Nikolaidou (2002).

While not always being able to conduct a simultaneous model analysis it is still important to try to understand the determinants of military spending. This is particularly true for developing and newly industrialising economies; Dunne and Perlo Freeman (2003a, 2003b) and Dunne, Nikolaidou and Mylonidis (2003) deal with this issue. Finally Batchelor, Dunne and Lamb, (2002) provide a detailed case study of determinants of military expenditure in South Africa. Overall, these studies are consistent with the general finding that military expenditure has a small negative impact on economic growth and on public finances and that changes in military spending are influenced mainly by strategic effects.

## **Objective 2: to investigate the restructuring of the global defence industry and how this has affected the procurement process.**

This objective was pursued in both theoretical and empirical studies. In DGLS (2004a) we construct a theoretical model of market structure in the global arms industry linking concentration, military procurement, international trade and regional conflict. We show how concentration depends on R&D costs as a proportion of the firm's output, the willingness of producers to import for their military needs and on the relative size of the external market of non-producers. DGLS (2004b) provides our most recent empirical analysis of the restructuring of the international industry, using the SIPRI company data. It finds that concentration increased in the defence industry, by more than would be expected from the fall in military expenditure, but this discrepancy can be accounted for by the other determinants of concentration found in our theoretical model. We also find that the industry is not as concentrated as other similar high technology industries. Again our theoretical model can account for this as arising from national governments' support for their own industry. This paper also reports an empirical analysis of the dynamics of the change in the size distribution of

firms in the industry companies within a framework of testing Gibrat's Law (that the growth in firm size is random).

We find that Gibrat's law is not rejected in the US sample, though it is in the rest of the world and in the pooled sample, though pooling the two samples is strongly rejected. For the rest of the world, the estimates indicate that small firms grow faster than large firms, though these results are sensitive to outliers, in particular two small arms producers (GKN and Celsius) which grew from less than \$200m to over \$1000m by acquisition. Excluding the very small firms with arms sales less than \$400m, we find that Gibrat's law holds almost exactly for the non-US sample as well as the US sample. This suggests that growth in size of firms is indeed random and that to explain the evolution of the market, one should look (as we do in our theoretical analysis) at features that are particular to the market, that is characteristics of demand, rather than to features that are particular to individual firms.

Empirical work on procurement has focussed on the UK experience with a paper and a chapter. Dunne and Macdonald (2002, 2003) analyse the changes in the nature of procurement practices and the relations between state and industry in the UK that have taken place. They consider the restructuring and reorganisation that has taken place, comparing the decades before and after the Cold War and finding that, despite the marked changes that have taken place, there is still evidence of considerable continuity.

**Objective 3: to investigate how procurement policy and the regulation of arms exports in the main arms exporter countries can be conducted when cost and market conditions are increasingly less visible to governments.**

Putting the asymmetric information aspects to one side for the moment, the complete information model of DGLS (2004a) provides some important insights into procurement and arms export regimes. This paper shows that there can be substantial gains to producers from co-operation in the procurement process, but also small gains to non-producers involved in regional arms races. Arms export controls that limit the level of technology that can be exported to non-producers distributes these co-operative gains from producers to non-producers. In addition two papers, Dunne and Perlo Freeman (2003a, 2003b) prepared for Oxfam, look at the impact of a responsible arms control policy on the UK economy, in general and in the case of UK component exports. Both have been used as background papers in Oxfam's campaign.

Turning to the private information issue, two theoretical papers cover different sources of *asymmetric information* that can arise among the main players in the arms trade and conflict situations. In a first paper (Garcia-Alonso and Levine (2003)), the tools of the strategic trade literature are applied to the international trade in arms. We examine the effect of arms controls, in the form of licensing delays, on the incentives to subsidize arms exports and conversely the effect of the WTO arms trade exemption on the incentives to break arms control agreements. Our main result is that arms controls and free trade commitments re-enforce each other. Licensing delays reduce the incentive to subsidize and free trade without subsidies reduces the benefits

of a unilateral abrogation of arms controls. Transparency actually *worsens* the Nash inefficiencies at play in that incomplete information leads to lower subsidies and lower arms exports. Whereas the lack of transparency associated with the arms trade is widely criticized by international community, our result suggests that in a limited sense it may have a beneficial role to play. If in response to this criticism, the arms trade does become more transparent, then the abolition of the WTO exemption for this sector will become a priority.

A second paper (Garcia-Alonso, Levine and Morga (2003)) studies the impact of Export Credit Agencies (ECAs) which provide guarantees, insurance and reinsurance against loss due to failed export contracts or payment default. In the U.K., the majority of such guarantees are given to defence projects. Contracts can fail to be honoured for two reasons: political default, owing to a change in the priorities of the importer government, or commercial default, owing to the importer country being unhappy with the quality of the product once it is delivered. In deciding whether or not to import a product a government must assess the incentives that the firm has to produce a high quality good. We prove that the existence of asymmetric information between exporter firm, exporter government and importing government with respect to the quality of the exported product or project can frustrate trade. Furthermore, we prove that export credit guarantees can improve the scope for trade by encouraging risk adverse firms to trade with countries that might engage in political default, but that it may also reduce the scope for trade by increasing the incentive of firms to export low quality. This suggests that an excessive level of coverage will have a negative impact on trade. The reason being that high level of coverage will decrease the expected losses of the firm if it decided to deliver low quality and will, therefore, discourage the importer country from signing an export deal with the firm. Our paper is especially relevant to goods or projects covered by an ECA whose quality is not easily verifiable prior to, or even after, project delivery. This is indeed the case with many defence products. A standard high degree of coverage might make it difficult to ensure that the firm has sufficient incentive to deliver.

### **Research Going Beyond the Original Objectives**

Although certain aspects of our model in DGLS (2004a) are tailored to specific features of military procurement (e.g., demand is partly driven by arms races, arms exports are regulated) other aspects have more general applicability. There are a number of industries in which governments use procurement, subsidies or regulations to influence or determine market structure to meet objectives other than those of pure competition policy. This may be because the government is itself a major customer as for arms or for pharmaceuticals in many countries. The government may also influence market structure because it believes that there are important externalities such as press freedom or public service broadcasting in the media industry. Although demand is driven by quite different forces in arms, pharmaceutical or media, in each case governments will perceive benefits from a greater variety of product (weapons, drugs, types of television channel). They are also likely to be concerned that competition alone cannot be relied upon to produce the optimal number of varieties or a structure of supply that meets national needs. Garcia-Alonso and Levine (2004) construct a model that addresses these more general issues and in addition goes beyond the assumption of monopolistic competition in DGLS (2004a) to examine markets with small numbers of firms who set prices strategically. On the whole the

effects on concentration of openness and the presence of an external market are reproduced in this model while the effect of strategic pricing by firms is to enhance these effects.

Export insurance coverage issues examined in Garcia-Alonso, Levine and Morga (2003) are just one form of *arms offsets* deal used in international trade. The use of arms offsets, in all their various forms, is a much-questioned policy (especially by economists) that has so far received little formal scrutiny. The project has had an input into the development of this area of research, some of which goes beyond the original objectives of the project. The Cape Town conference provided the basis for a volume of collected work on the economics of arms trade offsets (Brauer and Dunne, 2004a). This provides a valuable collection making contributions to the theoretical and empirical literature with a range of case studies. It includes contributions from the project and from the projects research network. Brauer and Dunne (2004b) provides an introduction to the book and Dunne and Lamb (2004) a case study of South Africa. South Africa is a particularly important case study for research on the economics of offsets as it is presently involved in one of the most controversial arms deals involving offsets and the degree of coverage, of transparency and of debate is unprecedented.

In a study that was motivated by post 9/11 events and also goes beyond the scope of the project as envisaged at the pre 9/11 time of submission, DGLS (2004c) present a game-theoretic model that addresses some of the issues and difficulties involved in managing asymmetric conflict. Asymmetric conflict arises in situations in which there is an asymmetry in the objective functions and information about the opponent's technology as two parties face a conflict situation. Our model aims to capture a situation where an incumbent power with a high share of status quo resources and access to traditional military technology, faces a contestant power who may consider the acquisition of an 'alternative technology' to be used in a conflict situation. In the face of uncertainty with respect to the specific type of alternative technology, the contestant may choose to acquire it and the incumbent may decide to continue to acquire the traditional military technology. The paper captures a number of stylized facts of the post September 11<sup>th</sup> world: the inertia that traditional powers have in the way in which they fight in conflicts, the very different access to resources by different conflicting powers, their very different shares of peace resources and the one-sided uncertainty that traditional powers face in identifying their adversary.

The paper includes a number of particularly interesting results: first, we prove that increases in the incumbent's level of military expenditure or effort will not only tend to encourage the use of alternative technologies, but it will also increase the technological difference between those technologies and the traditional technology used by the incumbent. This will have an adverse effect on the incumbent's conflict success probability. As a result, an increase in the access to alternative technologies will decrease the optimal level of effort exerted when a conflict is expected. Second, we are able to prove that a reduction in the fixed cost attached to choosing a technology alternative to the traditional one will actually make it more difficult, if at all possible, for the incumbent to try to prevent conflict by means of military effort. Basically, if the incumbent wants to prevent conflict, the level of effort required will actually be higher as conflict becomes more attractive for the challenger when

differentiation becomes an option. Third, as a consequence of the above, we conclude that as access to alternative technologies becomes easier, it will be less likely that the incumbent decides, even if able, to prevent conflict by means of military effort.

## **Activities**

This project built on one of the strengths of a previous ESRC-financed project on the arms trade by developing the *network of researchers* interested in this area. This project drew on valuable inputs from colleagues in this network at the cost to the ESRC of only travel and subsistence. Ron Smith continued his very successful research collaboration, while colleagues and ex-colleagues of Paul Dunne, Alvin Birdi, Sam Perlo Freeman, Eftychia Nikolaidou, Aylin Soydan and Duncan Watson developed their fruitful collaboration with him and Ron Smith. At the University of Kent, Antonia Morga engaged in productive collaboration with Maria Garcia-Alonso. In addition, Guy Lamb and Peter Batchelor continued working with Paul Dunne on South Africa and Jurgen Brauer was also involved in joint work. Jurgen Brauer, Todd Sandler from the US, Michael Brzoska from Germany, Elisabeth Skoens from SIPRI, Ali Tasiran from Gothenberg University, Christos Kollias from Greece, and Jacques Fontanel and Sylvie Mattely from France all provided valuable comments on the work of the project.

The *annual conferences* organised and supported by the project provided important opportunities for the network members to meet and discuss their work. It also gave the opportunity to present the work to an informed audience and to develop the network. These have become the leading international gathering of defence economists attracting delegates from all over the world. Details of the conferences are available on the webpage. As the webpage shows the conferences attracted an impressive range of researchers from across the world. It is heartening to see the continued support of the conference given there has been no sponsorship available to participants except for some of the keynote speakers. There is also a range of participants from academics to activists. This influence was extended in 2003 when the project members started an annual public lecture series at UWE Bristol, with Professor Ron Smith talking on “the Value of Defence”. This was very successful bringing together over 40 participants from government, industry, NGOs and academia as well as interested laypersons.

The project members also organised a high profile international conference in Cape Town which saw members of government, NGOs, academics and South African arms companies debating the issue. One outcome of this is a book edited by Dunne and network member Bauer provides an important contribution to the policy debate.

The conferences organised by the project have been in cooperation with Economists Allied for Arms Reduction (ECAAR). In addition, a UK NGO Campaign Against the Arms Trade has attended the annual conference, engaged in debate and found value in the project's output. (see the section on impact below for more details of these NGOs).

The project members presented papers at a range of conferences over the period:

## 2003

Papers presented to the *ESSA Conference*, Somerset West, South Africa, September 2003; the *ISINI Seventh International Congress* Lille, France, August 20-23, 2003; the *5<sup>th</sup> Annual Conference of the Association of Heterodox Economics*, Nottingham, July 2003; the *7<sup>th</sup> International Conference on Economics and Security*, Bristol, June 2003; the *Peace Science Congress*, Amsterdam, 1-3 June 2003; the *American Economics Association/ASSA Annual Meetings*, Washington January 2003, Peace Science Society Panel Sessions.

## 2002

Papers presented to *The Turkish Economic and Social Studies Foundation* meeting on “Defence and the Economy”, Istanbul, November, 2002; an International Conference on *Offsets and Economic Development*, University of Cape Town, Cape Town, September 2002; the *South African Trade and Industry Policy Secretariat Annual Forum*, Midrand, September 2002.

Plenary and paper presentations at *3<sup>rd</sup> Lisbon International Conference on Defence Economics*, 26-28<sup>th</sup> June 2002, ISEG-Technical University of Lisbon, Portugal; Papers presented to the “*Sixth Middlesex Conference on Economics and Security*”, Middlesex University Business School, June 2002; the *American Economics Association/ASSA Annual Meetings*, Atlanta January 2002, ECAAR and Peace Science Society Panel Sessions.

## 2001

Invited presentation to *South African Trade and Industry Policy Secretariat Annual Forum*, Midrand, September 2001; and on “Leveraging Defence Procurement: South Africa”, to George C Marshall Centre Conference “*Defense Economics III: Defense Industry and the State*”, Wildbad-Kreuth, Germany, August 2001. Co-sponsored by NATO Economic Directorate.

Presentations to the *Sixth Annual Conference on Econometric Modelling for Africa*, Pretoria, July 2001.

Presentations and keynote address to the *First International Conference on Defence, Security and Economic Development in the Balkans and Eastern Mediterranean*, Larissa, Greece, June 2001.

Presentations to the *Fifth Middlesex Conference on Economics and Security*, June 2001; the *First Rutgers Conference on Defence and Peace Economics*, New York. May 2001; an International Conference “*Disarmament, Arms Industries and Conversion in the Regions*”, Bremen, April 2001.

Invited oral presentation to the South African Parliament’s Public Hearings on *Estimation of Economic Offsets from the Recent Defence Procurement Programme*, Cape Town, February 6<sup>th</sup>, 2001

## Outputs

Our output from the project to date consists **27 completed papers**. This includes 9 published papers, 3 forthcoming papers, 7 papers under consideration at journals, 2 reports and one submission to a parliamentary public hearing in South Africa. We also presented our research at 18 conferences over the period of the project. Several other papers are in progress. All of these papers are available from the project’s web-site at:

<http://carecon.org.uk/Armsproduction/>

This website developed by the project has become an increasingly important resource for research in the area, with project output and conference materials made available quickly and conveniently. This has been particularly valuable for researchers in developing countries and others who have been unable to attend the conferences.

## **Impacts**

Over the course of both our ESRC-financed projects we have established links with both governmental and non-governmental users of our research. In particular:

### **Export Credit Guarantees Department**

Michelle Chen (Public Affairs Branch) at.  
PO Box 2200  
2 Exchange Tower  
Harbour Exchange Square  
London E14 9GS

### **Dfid and MoD**

Professor Ron Smith have advised Dfid on arms exports and MoD on estimates of defence industry employment .

### **SIPRI [www.sipri.org](http://www.sipri.org)**

The Stockholm International Peace Research Institute is a Swedish Institute that conducts research on questions of conflict and cooperation of importance for international peace and security, with the aim of contributing to an understanding of the conditions for peaceful solutions of international conflicts and for a stable peace. SIPRI publishes an Annual Yearbook as well as other research output.

The links with SIPRI (Stockholm International Peace Research Institute) have been particularly strong, with Dunne and Smith acting as referees for their Yearbook, Dunne being in their arms industry network and Dunne supervising senior researcher Elisabeth Skoens of SIPRI for a PhD on “Globalisation of Arms Production”.

### **ECAAR: [www.ecaar.org.uk](http://www.ecaar.org.uk)**

Economists Allied for Arms Reduction is a US-based NGO that seeks to promote objective economic analysis and appropriate action on global issues relating to peace, security and the world economy. It contains many nobel laureates and has affiliates throughout the world. Brauer is a Vice Chair of ECAAR and Dunne is the chair of the UK affiliate and. ECAAR provided financial support for the Cape Town conference and sponsors and participates in the UK conferences. ECAAR publish the *ECAAR Review*, a newsletter and a journal *Peace Economics, Peace Science and Public Policy*. Dunne is an editor of the *ECAAR Review* and contributed a chapter to the 2002 edition.

### **CAAT [www.caat.org.uk](http://www.caat.org.uk)**

The Campaign Against Arms Trade is a London based NGO working for the reduction and ultimate abolition of the international arms trade, together with progressive demilitarisation within arms-producing countries. Dunne made a presentation to a CAAT/CND conference in Manchester in November 2002.

### **Others**

Dunne and Smith have worked with Saferworld and Oxford Research Group to provide background research for their report on Arms Export subsidies.

## **Future Research Priorities**

We have identified four areas for future research by ourselves and some members of our network.

**The regulation of arms exports in the main arms exporter countries with informational asymmetries (work in progress):** In Garcia-Alonso, Levine and Morga (2003), the impact of transparency on security is determined by the type of information asymmetry introduced; in particular we assume that the government is uncertain about a cost parameter. To establish the robustness of our results, other types of asymmetry need are being considered, one of them being the actual quality or quantity of weapons being exported by the domestic firm or its competitors. This type of asymmetry may well have a very different impact on security.

**The impact of export insurance coverage:** There is a number of ways in which Garcia-Alonso, Levine and Morga (2003) can be extended. The ECG is a sub-optimal mechanism in that the ECGD is constrained to break even. A possible extension would be to relax such assumption by allowing the ECGD to extract rent from the firm. A second possible development of this research would study the *political economy* of export credit guarantees. Here one could look at the agency relationship with the ECA acting as an agent of the government in the exporting country, while still being the principal in the insurance game with the firm. In this framework, we might investigate the issue of the ECA being 'captured' by the firm, and thus address the impact of interest group power over the export credit guarantees and therefore, over the scope for trade.

**Asymmetric conflict:** our research suggests a number of interesting testable hypotheses regarding the nature of asymmetric conflict. Future work will draw upon a number of available data sets on conflict. There is a large Armed Conflict Dataset compiled by the International Peace Research Institute Oslo (PrIO) and Uppsala University, which covers all conflicts 1946-2000, we are beginning a statistical analysis of this. Although these have been extensively analysed using simple models there has been no analysis using modern longitudinal/panel techniques.

**Economic Effects of Military Spending:** Understanding the economic effects of military spending remains an important topic for research. Our research illustrates the value of developing data sets that combine the cross-country information with reasonable length time series data. The developments in panel data analysis should help in the analysis of these datasets. In addition, our research also showed the value of case study analyses of individual countries, or relatively homogenous groups of countries. Further work of this nature would make a valuable contribution to knowledge.