

Defence Economics: Achievements and Challenges¹

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1. Introduction

Defence economics is a relatively new part of the discipline of economics. One of the first specialist contributions in the field was by Hitch and McKean, *The Economics of Defense in the Nuclear Age* (1960). This article presents an overview of the achievements and challenges for defence economics. The achievements are based on a review of papers published in the journal *Defence and Peace Economics*, especially publications and progress since the tenth anniversary issue. The focus is on coverage of topics, including Special Issues. Major gaps in coverage are identified.

The choice of topics for challenges facing defence economics represents a personal view. These include the defence economics problems; UK nuclear weapons policy; project case studies based on the example of the Eurofighter Typhoon; the military production function and the role of military outsourcing; and some data problems illustrated with reference to the costs of conflict and the Iraq war.

2. Achievements

2.1. Definitions

The definition of defence economics has evolved to reflect new threats and new policy developments. During the Cold War and in its immediate aftermath, defence economics was defined as the economic study of defence, disarmament, conversion and peace. In the post-Cold War environment, the focus has been on

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the economics of war and peace. Modern definitions embrace the study of wars and conflicts both conventional and non-conventional conflict. Examples include the economic study of civil wars, revolutions and terrorism (e.g. Brauer, 2003; Barros and Sandler, 2003; Hartley, 2007; Hegre and Sandler, 2002).

Some of the pioneering contributions in the field were dominated by US economists (US economists are less dominant today). These included:

- i) Models of arms races (e.g. Richardson (1960); Intriligator and Brito (1989; Schelling (1966)))
- ii) Economic theories of alliances (e.g. Olson and Zeckhauser (1966); Sandler (1988)).
- iii) The demand for military expenditure (e.g. R. Smith (1980))
- iv) Defence, growth and development (e.g. Benoit (1973))
- v) The economics of military personnel, especially an all-volunteer force (Hansen and Weisbrod (1967); Oi (1967)). Here, it is interesting to compare UK and US experience. The UK introduced an all-volunteer force earlier than the USA, but compared with America, UK economists were not actively involved in the policy debate.
- vi) Procurement and contracting (e.g. Peck and Scherer (1962)).²

Since the end of the Cold War and in the post-Cold War world, there have been some new developments in defence economics. These reflected the end of the Cold War, globalisation and new security threats in the form of international terrorism (e.g. 9/11 attacks on the USA: see Sandler and Hartley, 2007). These new developments include:

- i) Economic studies of disarmament and the peace dividend (e.g. Hartley, K., *et al*, 1993). Here, a novel contribution was the analysis of disarmament as an investment process.
- ii) The arms trade (e.g. Levine, Sen and Smith, 2000)
- iii) Terrorism (e.g. Sandler, 1992)
- iv) Economic studies of conflict (Hartley and Sandler, 2003). Compare market analysis with conflict. Markets are characterised by voluntary trade and exchange based on the price mechanism; by markets in equilibrium; and by the growth of output (creative power). In complete

² A detailed reference list for these pioneering contributions is provided in Sandler and Hartley (1995).

contrast, conflict uses military force to achieve a re-allocation of resources; markets are in disequilibrium (chaos); conflict destroys markets; and conflict focuses on destructive power rather than creative power (i.e. it involves the destruction of physical and human capital).

v) Economics of peace-keeping (e.g. Solomon and Berkok, 2006).

2.2. The journal: Defence and Peace Economics

2.2.1. Background

The journal provides an indicator of the development of defence economics and its establishment as a reputable sub-discipline of economics (c.f. health economics). The journal was launched in 1990 with the title *Defence Economics* and was published four times a year. There was a UK Managing Editor, a North American Editor dealing with North American papers reflecting the presence of a substantial number of US defence economists, together with an international Editorial Board. In 1995, it was renamed Defence and Peace Economics to reflect the post-Cold War security changes and the increasing focus on disarmament, conversion and peace issues. In 2000, publication was increased to six issues per year which is a further reflection of the growing academic interest in the field. In late 2006, the typical lag between acceptance of a paper and its publication was about 12 months.

2.2.2. Features of the journal

Whilst the journal focuses on economics papers, it accepts good quality contributions from other related disciplines as well as articles written by policy-makers, industrialists and practitioners. Two distinctive features are its Country Survey Series and its Special Issues. To date, there have been some 20 Country Surveys, each designed to provide data, analysis and evaluation of a country's defence economy (e.g. data on defence expenditure; armed forces; demand for defence spending; and any defence industrial base). There remains scope for more Country Surveys of both major defence spending nations (e.g. USA) and nations which are less well-known (e.g. China; India; Iran; Iraq; Pakistan; new NATO members; North Korea).

There have been numerous Special Issues. These include special, topical and under-researched themes (e.g. terrorism; arms exports; defence R&D), tributes to leading defence economists (e.g. Jack Hirshleifer), conference papers focusing on a common theme as well as Issues designed to promote defence economics in a specific country (e.g. Canada; Greece; Spain; Turkey). Each Special Issue requires a Guest Editor who is responsible for the content of the Issue and the quality of the articles. Proposals for Special Issues are made to the Editors who will then commission the Issue, or the Editors might approach someone to take the lead and develop a Special Issue.

2.2.3. *The tenth anniversary issue, 2000*

The tenth anniversary of the journal was commemorated with a Special Anniversary Issue (Hartley and Sandler, 2000). This contained an article reviewing the coverage of the journal to that date. There were also articles on concepts of defence economics, arms races, conflict and exchange, defence and aid, manpower economics and disarmament.

This section summarises the main findings of the review of coverage from 1990 to 2000. The top 10 topics covered were (figures in brackets show number of articles):

- 1) Defence expenditure studies (29)
- 2) Procurement processes and policies (21)
- 3) Economics of alliances (18)
- 4) Conversion (17)
- 5) Defence industries and industrial base (16)
- 6) Military manpower (14)
- 7) Country surveys (11)
- 8) Terrorism, guerrilla warfare and insurgencies (11)
- 9) Defence and growth (9)
- 10) Public choice and defence (8)

In contrast, areas with relatively little coverage included articles on arms races, the arms trade, disarmament and arms control, the military production function, the nature of defence economics and defence budgets. In view of their importance and topicality, the small number of articles on arms races and the arms trade was surprising.

In 2000, various gaps in coverage were identified. These included game theoretic analysis of defence; peace economic studies, including peacekeeping missions, regional arms races and conflict resolution; contributions from related disciplines; and good quality case studies of defence industries, projects and of conversion (both successful and unsuccessful conversions).

2.2.4. *Progress since year 2000*

The record of publications since the 10th Anniversary Issue enables an assessment of the changing trends in defence economics. Since the 2000 Anniversary Issue (2000/1), there have been 41 issues of the journal with 221 articles to end-2006 (2006/6). Table 1 shows the topics with the greatest coverage over this period. In aggregate, these topics accounted for 87% of all topics published over the period. Inevitably, there are problems of classification, especially with defence-growth and defence expenditure studies as well as with personnel and military production function articles. Nonetheless, compared with the 1990 – 2000 period, there are some new topics in the top list. These include conflict, arms

ances, terrorism, the military production function, peacekeeping, defence R&D and the arms trade.

Table 1. Coverage from 2000 to 2006

Topics	Number of articles
Defence –growth	23
Conflict	22
Defence industrial base	20
Arms races and arms control	17
Terrorism	16
Military production function	15
Defence expenditure	14
Peace and peacekeeping	12
Debt issues	10
Defence R&D	10
Alliances	9
Manpower economics	9
Arms trade	8
Country surveys	8

Equally interesting are the topics which have received little coverage. These included European defence policy, disarmament, conversion, security policy, defence budget trade-offs, procurement, regional issues, public choice and the nature of defence economics. The list of Special Issues is a further indicator of developments in defence economics. Since 2000, there have been 16 Special Issues reflecting new topics, new themes, conference proceedings and efforts to promote defence economics in specific countries, namely, Canada, Greece, Spain and Turkey. Table 2 shows the coverage of Special Issues since the Anniversary Issue.

Table 2. Special Issues, 2000 – 2006

Arms exports	Economics of Conflict, Civil War and
Defence in Greece and Turkey	Peace- Historical Perspectives
Economics of Defence: Perspectives	Symposium on Defence Economics
from Spain	Deficit, Debt and Defence
Civil Wars	Future of the Defence Firm
Defence and Economic Development in	Canadian Perspectives on Defence
the Balkans	Economics
Economic Analysis for Defence	Defence R&D
Decision-Makers	Peacekeeping
Internal and External Threats	Essays in Honour of Jack Hirshleifer

Major gaps remain, some of which were identified in the Anniversary Issue. There is a need for good quality analytical and critical case studies of conflict, defence industries, projects and conversion (both successful and failed conversions). Examples include the Iraq war and experience with major weapons projects such as aircraft carriers, combat aircraft (e.g. F-22; JSF; Typhoon) and submarines. There is also scope for more articles from policy-makers, the armed forces and from industry.

Other opportunities exist in procurement and contracting and analysis of the efficiency of the armed forces and the military production function. The history of economic thought in war, defence and peace is another gap. Finally, globalisation issues need to be addressed, embracing global threats, global defence industries and global military solutions (e.g. peacekeeping; *ad hoc* military alliance such as 'coalitions of the willing').

3. Challenges

3.1. The Defence Economics Problem

This is the standard economics problem of choice under uncertainty. It reflects two trends. First, for most nations, defence budgets in real terms have been either broadly constant or falling. Second, input costs for equipment and military personnel have been rising. Unit equipment costs have doubled every decade leading to smaller numbers of equipment ordered from defence industries and smaller numbers for the armed forces (e.g. a long-run downward trend in the numbers of combat aircraft, tanks and warships in the armed forces). Also, for military personnel, the costs of an all-volunteer force have to rise faster than wage increases in the civilian sector (i.e. to compensate for the net disadvantages of the military employment contract: discipline; mobility; danger; long and unsociable hours on operations; and the probability of injury and death). The result of these trends is the need for difficult defence choices. Whilst higher defence spending will 'solve' some of these problems, it shifts the choice problem from defence to social welfare spending and taxation levels (i.e. 'guns v butter' choices).

Interestingly, the end of the Cold War has made no difference to unit cost escalation: it has continued. For example, the UK cannot afford a successor to Typhoon combat aircraft; attack helicopters are becoming unaffordable so that there is a future for main battle tanks; and by the time UAVs are as capable as manned aircraft, they will be equally as expensive and hence just as unaffordable (Pugh, 2007).

There is a further dimension which affects the defence economic problem. Evidence shows that there is a positive relationship between annual defence R&D spending some 10 – 25 years earlier and military equipment capability (or years of advantage). This relationship is subject to diminishing returns. It shows that the USA is the world leader and that it is some 5-6 years ahead of the UK and

France, some 8 years ahead of Germany and about 12 years ahead of Sweden. The result is that the US defence industry has an international competitive advantage reflected in its defence export performance. But the US advantage comes at a price. Its lead over the UK involves an annual defence R&D budget which is five times that of the UK (Middleton, *et al*, 2006).

There are a variety of responses to the defence economics problem. These include 'equal misery' affecting all the armed forces and involving less training, fewer attrition buys, some project cancellations and delays in delivering new equipment (i.e. shifting the new equipment programme to the right). Alternatively, there could be a defence review involving a major shift in a nation's defence commitments (e.g. abandoning some capabilities; role specialisation); or nations could seek to improve efficiency in procurement through competitive purchasing and military outsourcing. For European nations, an EU defence policy is a further option.

Economic theory also offers some policy guidelines and principles for formulating defence policy. First, the principle of final outputs. This requires a focus on the final outputs of defence in terms of peace, security and protection or more realistically in terms of defence capabilities. For example, it might be that a nation's defence budget provides the capability to be involved in a major conflict as part of an international coalition (e.g. UK in Iraq and Afghanistan) or to be involved in, say, three small to medium scale operations (e.g. peacekeeping). Such an approach shows the limitations of focusing on inputs. Typically, debates about defence policy focus on the implication of budget cuts for the size of the army, navy and air force (e.g. cuts in the numbers of infantry regiments, tanks, warships and combat aircraft squadrons). This is the wrong focus. Instead, the key question is what contribution do these inputs of soldiers, warships and aircraft make to the final outputs of peace and security and what would be the impact of marginal changes in these inputs (e.g. reducing the size of the navy by 5% and increasing the size of the army by 5%)?

The second economic principle is that of substitution. This recognises that there are alternative means of achieving protection. For example, there are substitution possibilities between civilians and military personnel; between reserves and regulars; between attack helicopters and tanks; between cruise missiles/UCAVs and manned combat aircraft; between air power and land forces; and between nuclear and conventional forces. Some of these substitution possibilities affect the traditional monopoly property rights of the armed forces. It might mean cruise missiles operated by the army and navy replacing manned combat aircraft operated by the air force.

The third economic principle is that of competition as a mechanism for achieving efficiency. Here, there are opportunities for introducing or extending competition to the purchase of defence equipment (e.g. buying from overseas rather than from a national defence industrial base) and to military outsourcing. Typically, the armed forces operate a monopoly of services provided by 'in-house' units. Such

activities could be opened-up to competition by allowing private firms to bid for this work (e.g. catering; training; transport; managing military bases and training ranges).

3.2. UK Nuclear Weapons Policy

Interestingly, the first specialist defence economics text book was entitled *The Economics of Defense in the Nuclear Age* (Hitch and McKean, 1960). Some 45 years later, the UK is considering whether to replace its Trident strategic nuclear force. This decision will be controversial involving political, military and moral issues. But economics cannot be ignored since costs are involved.

Economists assess a Trident replacement decision by starting with a conceptual framework. The policy options need to be identified embracing submarine, air and land-based alternatives for a strategic deterrent (including the option of running-on Trident for longer than its original planned service life). The options then need to be assessed using a cost-benefit framework. Costs include acquisition, life-cycle and disposal costs. Benefits embrace the military effectiveness of the options in relation to the military requirement. There are also wider economic and industrial benefits to be included in the evaluation. These include such factors as security of supply, the retention of industrial capabilities and the impact on jobs, technology and any exports.

Opportunity costs cannot be ignored. One estimate suggests replacement costs of £15-20 billion over 20 years (based on building a new Vanguard/Trident force at 2006 prices); but the estimate might be double that figure or considerably less. No official figures are yet available. An expenditure of £15-20 billion could be used for alternative defence spending on conventional equipment. For example, £15-20 billion might buy 30-40 Type 45 destroyers; or 2 aircraft carriers plus their JSF aircraft and helicopters; or 230-310 Typhoon combat aircraft (these are illustrative examples based on acquisition costs only). Alternatively, there are Trident versus social welfare trade-offs. Alternative civil spending is available in the form of 100 – 130 new hospitals (capital costs only over 20 years) instead of a Trident replacement. A Trident replacement also affects the future of the UK submarine industrial base (UK SIB). Without a submarine replacement for the UK's nuclear deterrent force, it will be difficult and costly to maintain a UK SIB. But a submarine replacement will require contract negotiations with a UK monopoly supplier (BAE Systems) and the associated problems of determining prices and profits on non-competitive contracts and providing efficiency incentives whilst avoiding 'excessive' profits. As always, there are no costless options.

3.3. Project Case Studies: Typhoon

Typhoon illustrates the opportunities for in-depth case studies of major equipment projects and for the economic evaluation of such programmes. Economic theory suggests guidelines for an efficient defence industrial policy in an alliance and these can be used to assess the efficiency of the Typhoon programme. Efficient programmes are characterised by gains from trade based on specialisation by comparative advantage; by gains from economies of scale and learning; and by reduced duplication of costly R&D. Typhoon fails on gains from trade since its work-sharing arrangements are not based on comparative advantage between partner nations. Instead, work is allocated on the basis of *juste retour* reflecting the size of national orders and the desire of each nation for a share of the high technology on the programme and for national final assembly lines. However, Typhoon scores more highly on gains from scale and learning through combining all national orders into one large-scale order; but it loses some economies of learning through duplicate final assembly lines (but final assembly is 3-5% of production costs). Finally, there are some gains for Typhoon from reduced duplication of costly R&D programmes (e.g. four nations choosing one R&D programme).

The large-scale public expenditure on Typhoon of over Euros 54 billion (2004 prices for development and production) has attracted considerable public scrutiny by national Parliaments. Criticism has also been made of the continued relevance of Typhoon in the new post-Cold War security environment, the high and rising costs of the project, its considerable delays, the inefficiencies of its industrial arrangements and the bureaucracies of the customer governments. However, there has been little information on the economic benefits of Typhoon. What are its benefits in terms of jobs, technology spin-offs and balance of payments (exports and import-savings)? Such economic and industrial benefits are part of a complete cost-benefit economic evaluation of Typhoon (Hartley, 2006).

3.3.1. Economic benefits

Typhoon supports some 100,000-105,000 jobs directly and indirectly in over 400 European companies. In 2006, these jobs were distributed: Germany and Italy with 20,000 each; Spain with 25,000; and the UK with 40,000 jobs. Many of these are highly-skilled and high wage jobs in development, production and support. Many of Typhoon's labour skills are highly transferable (e.g. to motor car and electronic industries; and to Airbus 380 work).

There is an impressive list of technology benefits and spin-offs from Typhoon. Examples include carbon fibre technology, flight control systems and aero-engine technology. There are spin-offs to civil aircraft, to motor car industries (including Formula 1 racing cars in Italy and the UK) and further spin-offs to supply chains (including the application of modern business practices).

Typhoon offers export and import-savings benefits which further contribute to providing jobs and to maintaining the European defence industrial base which represents an alternative source of supply to the USA. In late 2006, there were export orders for 90 aircraft valued at Euros 9.5 billion. Also, the import-saving contribution of Typhoon was estimated at Euros 33.5 – 54 billion (acquisition costs only: the higher estimate assumed that Typhoon was the least-cost solution and the lower estimate assumed a mixed buy of US F-15E and F-18E/F aircraft). On this basis, the total balance of payments contribution of Typhoon is some Euros 43 – 63.5 billion.

3.3.2. A critique

The economic benefits of Typhoon need to be evaluated critically. The opportunity cost question cannot be avoided. Would the resources used on Typhoon make a greater contribution to national output if they were used elsewhere in the economy?

Similarly, examples of technology spin-offs appear impressive but they are qualitative and not quantitative: there are lots of examples and case studies, but little evidence on their valuation. What is the market value of these spin-offs and what is their transmission mechanism? One estimate based on the Netherlands experience with its planned JSF purchase suggested that Typhoon technology spin-offs might be valued at Euros 7.2 billion (2004 prices) but this is likely to be a lower-bound estimate (Hartley, 2006, pp17-18). Some of the mechanisms whereby technology from Typhoon is ‘spun-out’ to other sectors of the economy have been identified. These included labour turnover with skills transferred elsewhere either within a company or to other firms (e.g. the motor car industry in Germany); through staff on Typhoon acting as consultants (e.g. to Formula 1 racing car industry); through the supply chains; and through links with universities (Hartley, 2006, p17).

There is a more fundamental critique of the economic benefits of Typhoon concerning their market failure dimension. Do arguments about jobs, technology and exports reflect genuine market failures justifying state intervention; is state intervention likely to be worthwhile; and are defence projects such as Typhoon, the most efficient form of intervention to correct market failures? In relation to jobs and exports, it is likely that labour and foreign exchange markets are working reasonably well; but spin-offs are a beneficial externality suggesting failure in technology (R&D) markets.

Finally, collaboration inefficiencies on Typhoon cannot be ignored. These embrace development and production and are reflected in the work-share arrangements, the industrial organisation and the customer governments of the partner nations all of which have led to cost increases and delays. For example, the Typhoon programme lacks a single lead company as prime contractor with

management authority and financial responsibility and also it lacks a single customer. Governments are subject to changing requirements, national agendas, industry lobbying and different budgetary pressures (national projects are not immune from such features). Overall, the Eurofighter company recognises that about one third of the 54 month delay was due to the company and its management organisation, with the rest of the delay attributed to the partner governments, their budget problems and to changes following the end of the Cold War.

The Typhoon programme offers some lessons for future collaborations. First, work-shares need to be based on efficiency and competitiveness criteria rather than political bargaining and equity between the partner nations. Second, collaboration needs a single prime contractor subject to the risks of a fixed price or target cost incentive contract. Despite its recent problems, Airbus is an example of a successful collaboration.

4. Conclusion: Further challenges

4.1. Challenges for the Armed Forces

Private industry makes continuous change due to changing consumer preferences, new technology and the emergence of lower cost rivals at home and overseas. The Armed Forces cannot avoid the need to change. The drivers for change come from budget cuts, new technology, new threats and new conflicts and some times from government through a new, innovative defence minister (e.g. McNamara).

The need for change in the Armed Forces means that they have to address radical solutions and depart from the traditional ways of doing business. For example, the substitution principle with, say, a greater use of reserve forces and more military outsourcing has to be addressed in an era of defence budget constraints and a preference for social welfare spending. But the search for efficiency improvements in the Armed Forces is limited by their lack of private market incentives in the form of competition, the profit motive and the policing role of capital markets (i.e. threats of takeovers and bankruptcy).

4.2. Challenges for defence economics

There remains a massive research agenda based on traditional and new topics. Traditional areas include the scope for further analytical and empirical work on the military production function and the efficiency with which the Armed Forces convert inputs into military outputs. Here, there is scope for the international comparison of labour-capital relationships in such forms as the numbers of military personnel per warship, tank unit and combat aircraft squadron. Military outsourcing also provides a check on the internal efficiency of various activities of

the Armed Forces and questions arise about the optimal extent of such outsourcing (e.g. combat units).

Data problems remain, but the collection of reliable data provides a public good subject to free-riding and this is not an attractive route to fast promotion in the economics profession! Two examples illustrate the challenges. First, there is a need for more data on the defence industrial base for each nation in the world. China is an obvious data gap. Also, there is a lack of data on defence R&D, especially its inputs of scarce scientists and engineers. Second, new studies of the economics of conflict require data on the costs of conflict. Such data are difficult to obtain. There are military costs and civilian costs to be considered. Ideally, data are needed on the planned military costs and final outcomes, including the impact of conflict on all participating nations. Even the apparently simple task of obtaining data on the military costs of the conflict and peace-keeping phases of operations in Afghanistan and Iraq are fraught with difficulties. There remains scope for a proper costing of the conflicts in Iraq and Afghanistan.

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