

CHAPTER 3

Measuring Defence Output : An Economics Perspective

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This chapter examines the measurement of defence output from an economics perspective. Economic theory offers some policy guidelines for determining the optimal defence output for any society. As an optimising problem, the economics rule is to aim at the socially desirable or optimal defence output which is achieved by equating additional or marginal costs with additional or marginal benefits. While the economics approach is difficult to ‘operationalise’ into a set of clear unambiguous policy guidelines, it does provide a framework for designing valuations for defence outputs and activities. Experience of measuring defence outputs is reported for the UK, Australia, New Zealand, a group of European nations and the USA.

CHAPTER 3

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I. Introduction

Measuring defense output is a necessary step to successfully apply military cost-benefit analysis to evaluate alternative security investments. Other chapters in this book focus on what economists call “intermediate outputs” (e.g. military forces). This chapter offers a higher-level “macro-economic” perspective of overall defense output that encompasses total defense spending.

In most countries, the defence sector absorbs substantial scarce resources with many valuable alternative uses (schools, hospitals, etc.). Whereas defence expenditures are well known within each country, there is no single indicator of value (or benefit) of overall defence output. This contrasts with

the valuation of private sector outputs in market economies. In defence, the economist's solution to measuring output assumes output equals inputs (a convention widely used across the public sector), or that the value of defense output is roughly equivalent to expenditures made to produce that output.

In sharp contrast, measuring the value of market outputs is not usually regarded as a policy problem. Market economies 'solve' the problem through market prices that reflect choices of large numbers of buyers and sellers. Defence, however, differs in several key ways from private markets, which helps explain the challenge in measuring and valuing defence output.

An important step to apply military cost-benefit analysis to evaluate security investments is to discuss output measures. This chapter examines the measurement of defence output from an economics perspective. Specifically, the chapter identifies key questions which have to be addressed in measuring overall defence output. These include: What is defence output? How can it be valued? Under what conditions is it a worthwhile investment?

Economic theory offers some policy guidelines for determining the optimal defence output for any society. As an optimising problem, the rule is to aim at the socially desirable or optimal level of defence output. This is achieved by equating additional or marginal costs of proposed defense expenditures with additional or marginal benefits. While the economics approach is difficult to 'operationalise' into a set of clear, unambiguous policy guidelines, it does provide a framework for designing valuations for defence outputs and activities.

This chapter is organized as follows. Section II reframes the defence output measurement issue as an economic problem utilizing insights from public goods, public choice, and principal-agent models. Section III presents the military production function as an early attempt to quantify defence outputs, and reveals some challenges in operationalizing the model. Section IV discusses more recent attempts at measuring defence outputs through the transformation of defence budgets reporting. Section V analyzes both economic and non-economic benefits of defence, while Section VI surveys international experience in measuring defence outputs. Nations surveyed

include Australia, New Zealand, the United Kingdom (U.K.), the United States (U.S.), and a group of European nations.

II. Economic Theory as a Guide

Public Goods

Defence is a classic example of a public good, and its desired outcome in the form of peace is also a public good. A public good is non-rival and non-excludable. For example, living as neighbors in the same city, my consumption of air defence protection does not affect your consumption and, once provided, I cannot exclude you from its consumption nor can you exclude me. In sharp contrast, private goods such as motor cars and TV sets are rival and excludable. Your payment and consumption of those items means that I cannot simultaneously use them (unless you choose to share), and private property rights guarantee your exclusive ownership, so that you can legally exclude me from using them.

The public goods features of defence provide incentives for free-riding. Since I cannot exclude you from the benefits and you cannot exclude me, each of us is inclined to let the other pay for protection. Free-riding is a contentious issue both within a nation and between nations in a military alliance (e.g. NATO, and U.S.-Canadian security). This ultimately results in a nation's citizens failing to reveal their true preferences for, and valuations of, defence. A challenge for the state in providing and financing defence is that it does not know the true preferences of the potential beneficiaries of defence: It cannot easily quantify the volume of the defence public good demanded by consumers and estimate the true price the beneficiaries are willing to pay (Engerer 2011).

Theoretical solutions exist to estimate the optimal amount of a public good, but are difficult to operationalise in practice (Cornes and Sandler 1996). Public opinion polls can be used, but these are a limited mechanism for accurately assessing society's opinions on defence spending and defence policy and the willingness of citizens to pay for defence (Zaller and Feldman 1992).

Alternatively, one can frame the question of “how much defence is enough?” presenting it as an optimization where the economic decision rule is to achieve a socially desirable or “optimal” defence output. In principle, this is found by equating marginal costs with marginal benefits. This approach is difficult to ‘operationalise’ into a set of clear and unambiguous policy guidelines. As discussed in the introductory chapter, marginal costs and especially marginal benefits of many defense investments are not immediately obvious, and are difficult to quantify.

The economic model assumes a social welfare function showing society’s preferences between defence (security) and civilian goods: Again, this is an attractive concept but not one which is readily operationalised or easily identifiable for any society. Moreover, the benefits of defence are complicated by its public good and free-riding characteristics. Voting systems may also not be reliable and accurate methods of revealing preferences for specific public goods and services. Typically, elections involve choices between political parties that offer various tax and spending policies, where defence budgets and security policies are often buried in a wider policy platform. Problems can also arise in attempting to aggregate voter preferences into a ranking for society as a whole (the voting paradox: Tisdell and Hartley 2008). Further problems arise since the economic model assumes maximising behaviour on the part of individuals, when most agents might instead be satisficers, willing to settle for acceptable solutions short of the optimum (Hartley 2010b).

Markets

There are several major differences between private markets and public (defence) markets. Private markets involve prices that reveal society’s valuation of outputs, where these prices reflect market incentive and penalty mechanisms. Goods that are ‘private’ rather than public are characterized by both excludability and rivalry; large numbers of private consumers and buyers; rivalry between firms; motivation and rewards through profits; and a capital market that imposes penalties on poor economic performance through take-overs and the ultimate sanction, bankruptcy (with managers often losing their jobs).

Public bureaucracies such as the Armed Forces lack such incentive and penalty mechanisms, and they consequently tend to be slow to adjust to change. Often, change in the Armed Forces results from budget pressures, new technology, victories and defeats, and occasionally, views of senior military leaders (Solomon et al. 2008). In contrast to private markets, there is no market price for publicly provided defense forces: For example, there are no market prices for submarine or tank forces.

Although some rivalry exists between suppliers (Navy, Army, Air Force, etc.), there is no profit motive for public suppliers, nor capital market pressures corresponding to take-overs and bankruptcy in private markets. Defence has another distinctive feature reflected in the state-funding and state provision (ownership) of its Armed Forces. Governments are monopsony buyers and monopoly providers of Armed Forces.

This contrasts with private markets where there are large numbers of buyers and rivalry amongst suppliers. State-owned and funded defence markets are less likely to undertake worthwhile changes (Tisdell and Hartley 2008, Chapter 10). There is also a unique military employment contract which differs drastically from private sector employment contracts. The military employment contract requires military personnel to obey commands which relate to type, duration, location, and conditions of work (e.g. world-wide deployments) with significant probability of injury and even death. Such a contract contains elements resembling indentureship and command systems.

Each of the Armed Forces is a monopoly supplier of air, land, and sea systems with monopoly property rights in the air, land, and sea domains. There are barriers to new entry which prevent rival internal Armed Forces from offering competing products. For example, armies often operate attack helicopters and unmanned aerial vehicles (UAVs) which are rivals to close air support and surveillance provided by air forces. Similarly, land-based aircraft operated by air forces are alternatives to naval carrier-borne aircraft. Efficiency requires that there be a mechanism for promoting such competition; instead, each Service guards its traditional monopoly property

rights in the air, land, and sea domains thereby creating barriers to new entry.

This has an impact on efficiency. Specifically, is the correct amount of output being produced? Is the correct mix of inputs being used? As monopolies with significant barriers to entry, each of the Armed Forces lacks strongly competing organisations and, hence, has less incentive for efficiency improvements and for innovation (where efficiency embraces both allocative and technical efficiency).

Allocative efficiency requires the choice of socially desirable output, and technical efficiency requires the use of least-cost methods to produce that output. Again, problems arise in determining allocative efficiency (see a discussion below on principal-agent models). Technical efficiency, however, can be assessed by allowing activities traditionally undertaken ‘in-house’ by the Armed Forces to be ‘opened-up’ to competition from private suppliers (market testing leading to military outsourcing). Indeed, the formulation of such competitions can offer improvements in allocative efficiency (e.g. by inviting competition for different levels of service in order to identify true marginal costs for different levels of output or service).ⁱⁱ

Internal defence markets lack other incentives of private markets. There are no profit incentives to stimulate and reward military commanders to search for and introduce productivity improvements or to identify new and profitable opportunities (for example, the role of entrepreneurs in private markets). The absence of a capital market also means that military managers are unlikely to lose their jobs for poor performance and that there are no capital market opportunities for promoting and rewarding mergers and take-overs. For example, a military commander of a regiment cannot merge with another regiment to achieve economies of scale and scope, nor can an Army regiment acquire Air Force and Naval transport units where such mergers might offer both cost savings and output improvements (such as horizontal, vertical, and conglomerate mergers).

Uncertainty dominates defence policy. Defence policy has to respond to a range of future threats, some of which are unknown and unknowable.

Assumptions are needed about likely future allies and their responses to threats, the location of threats, new technologies, and the time dimension of threats (e.g. today, in 10–15 years, or 30–50 years ahead where uncertainties are greatest). These uncertainties mean that forces have to be capable of adapting to change, and that today’s defense investments must be capable of meeting tomorrow’s threats. Admittedly, the private sector also faces considerable uncertainty about future markets and new technologies, and these unknowns extend over lengthy time horizons. Defence is different, however, in that uncertainties are dependent upon, and determined by, governments, nation states, and some non-state actors, rather than by the actions of large numbers of private individuals as consumers, workers, and shareholders.

There is one further key difference between defence and private markets. Defence aims to avoid conflict, but where conflict arises it often destroys markets and valuable infrastructure and creates disequilibrium as resources are re-allocated to military forces to gain strategic advantage, with consequent opportunity costs in civilian goods and services. War involves the destruction of labour and capital. In contrast, private markets seek the optimal mix of labour and capital to provide goods and services through voluntary trading and exchange. Resource allocation is based on price and profit signals that lead to “creative destruction” reflected in continuous investment in new innovations, inventions and the output of new goods and services.

Public Choice and Principal-Agent Models

Defence decisions are made in political markets which is another reason they depart from the economist’s optimising solution. Political markets comprise voters, political parties, bureaucracies, and interest groups—each pursuing their own self-interest. Voters as taxpayers are “principals:” They want something provided by government and appoint “agents” to perform the necessary tasks. The challenge for principals is to design incentive mechanisms to ensure that agents pursue the aims of the principals rather than their own objectives. For example, voters as principals seek peace, security, and protection, but the priority of their agents in Defence Ministries

and the Armed Forces might be to subsidize costly local goods and services because doing so offers jobs, new technology, or export benefits which contribute to re-election of the governing party.

Limitations of the voting system as a means of expressing voter preferences for defence spending constrain principals (voters) in their attempts to guide their agents (elected politicians and bureaucrats). Free-riding further affects the willingness of voters to accurately reveal their preferences for defence. Principals also often lack the necessary information to make informed and rational defence choices in their voting decisions. The result is that agents often have a wide scope in shaping national defence policy and in pursuing their own self-interests (e.g. re-election).ⁱⁱⁱ

The principal-agent model has implications for cost-benefit analysis, resource-use, and efficiency in defence markets. It also has implications for measuring the benefits of defence outputs where these reflect a combination of principal and agent choices. The model can also be linked to the political market where defence choices are made. In political markets:

- Voters and taxpayers as principals will seek to maximise the benefits (satisfaction) from their votes.
- Political parties are vote-maximizers; governments seek re-election and are the agents of voters.
- Bureaucracies can be modelled as budget-maximizers acting as agents of the government.
- Producer (e.g. defense industry) groups are profit- or rent-seekers in their roles as agents of the defense procurement agency or military bureaucracy.

The principal-agent and public choice models provide a useful analytical framework to help understand the military-industrial-political complex and its influence on defence choices and outputs. As principals, voters are generally poorly informed about defence policy so they defer to various agents to make their defence choices—namely, governments, civil servants in Defence Ministries and procurement agencies, and the Armed Forces. In turn, these agents are influenced by powerful producer groups in the form of

large defence contractors (e.g. via lobbying) seeking lucrative defence contracts.

Examples of the influence of the military-industrial-political complex on defence choices abound. Government Ministers will be aware of the vote-consequences of defence choices (e.g. impacts of base and plant closures and the benefits of awarding defence contracts to firms in marginal constituencies). Defence Ministries and the Armed Forces as budget maximizers are tempted to over-estimate the threat and under-estimate the costs of their preferred policies and projects. Exaggerating the threat from terrorism enables the Armed Forces to obtain larger defence budgets. Understating costs of a new weapon system in a cost-benefit analysis allows the project to start, and once started projects build interest groups and become difficult to stop (a key factor in the ‘optimism bias’ that often leads to contract cost overruns).

Defence contractors also have an incentive to make optimistic claims to pump up perceived benefits and increase their chances of being awarded valuable defence contracts. For example, claiming that the contract will contribute valuable jobs, technology, spin-offs, exports, and that it is ‘vital’ to the future of the national defence industrial base. Rarely is attention given to opportunity costs: Namely, whether the resources used in the defence project might provide even greater net economic benefits if used in alternative sectors of the economy. Overall, public choice and principal-agent models reveal how special interest groups influence military investment decisions and defence outputs.

III. The Military Production Function

Another contribution from economic theory to output measurement comes in the form of the military production function. This is an input-output relationship that attempts to relate all defence inputs to a final defence output. Inputs comprise technology, capital (bases, equipment, spare parts, etc.), and labour (military personnel in the form of conscripts and/or volunteers, civilians, contractors, etc.). A formal expression of the function is:

$$Q = f(A, K, L) \tag{1}$$

where Q is defence output and A, K and L are inputs of technology (A), capital (K), and labour (L).

While the model appears attractive, there are at least four major caveats. *First*, a production function assumes factor inputs are combined to minimise costs. This assumption is unrealistic in view of the lack of efficiency incentives in internal defence markets: There are few rewards or penalties to achieve least-cost production. *Second*, all defence inputs have to be identified and correctly valued. *Third*, defence output is simply asserted without recognising the problems of identifying and measuring output, including the multi-product nature of overall defence output. *Fourth*, the model simply identifies defence outputs resulting from various inputs: There are no criteria for determining society's preferred defence output (the "optimal" defence output).

Two central problems with military production functions arise over inputs and outputs. Consider the problem of identifying and valuing all relevant inputs. These comprise technology, capital, labour, and include the following items:

- Technical progress as reflected in inputs embracing new equipment and new military facilities, including communications;^{iv}
- Physical capital comprising a mix of equipment, military bases, land, and logistics (repair and maintenance);
- Human capital comprising military personnel reflected both in their numbers and in their human capital and the skills and productivity of the military labour force.^v

While measuring inputs is a challenge, identifying, measuring, and valuing defence output is even more challenging. Economic theory simply asserts the concept of defence output without exploring its definition and multi-product nature. Few published studies have estimated military production functions. Typically, such studies have estimated readily identified measures of effectiveness, such as providing an air defence

capability, the numbers of aircraft destroyed, or the number of aircraft sorties per day. This approach is used in cost-effectiveness studies that focus on intermediate defence outputs (Hildebrandt 1990; 1999).

For example, a cost-effectiveness study of air defence would compare the costs and effectiveness of alternatives such as land-based air defence missiles versus manned fighter aircraft; or anti-submarine capability would compare land-based maritime patrol aircraft versus naval frigates; or anti-tank capability would compare missiles and attack helicopters. A different approach used in a more recent study estimated a military production function where various defence inputs were used to estimate the probability of winning in various conflict scenarios (Middleton et al. 2011).

A variant of the military production function is a defence R&D production function. This shows that current defence R&D determines future military equipment quality, with an impact on future defence output. The relationship between defence R&D and equipment quality is positive, but subject to diminishing returns and substantial lags. For example, today's military equipment quality was determined by defence R&D spending some 10–15 years ago.

It can be informative to convert equipment quality into a time advantage. Thus, over the period 1991–2001, U.S. military equipment was six years ahead of that of the U.K., seven years ahead of France, and twelve years ahead of Sweden (Middleton et al. 2006). The defence R&D production function can be expressed as:

$$E_q = f(RD_d, Z) \quad (2)$$

where E_q is military equipment quality (e.g. British versus U.S. tanks); RD_d represents defence R&D, and Z captures all other factors.

The defence R&D production function needs more theoretical and empirical work. For example, 'other factors' might contribute to equipment quality and these need to be identified specifically in the model. Furthermore, links between equipment quality and military capability need identifying, including the role of variables such as military skills which also

contribute to final defence output. The model is also limited in focusing on aggregate defence R&D spending without any analysis of the most effective mix of research and development spending. More empirical work is needed to determine the most cost-effective ratio of research to development work within total defence R&D budgets, and the impact of that R&D on equipment quality and future output/capabilities.^{vi}

Traditionally, defence outputs were measured on an input basis, where input costs were assumed to equal the value of outputs. Table 3.1 presents some input data of the type typically used for measuring some of the inputs in a military production function.

Table 3.1 Defense Inputs for a Group of Nations (2009)

Country	Defence spending (US\$ millions, 2009 prices)	Defence share of GDP (%)	Armed Forces Personnel (Numbers, 000s)	Defence R&D (US\$, millions, 2000 prices)
Australia	20109	1.8	58	242.7
Canada	19869	1.5	67	201.6
China	98800	2.0	2285	NA
France	54446	2.1	243	3643.5
Germany	47466	1.4	254	1103.2
India	36600	2.6	1325	NA
Italy	30489	1.4	197	64.9
New Zealand	1358	1.2	9.8	NA
Spain	16944	1.2	134	1666.5
Sweden	6135	1.3	13	218.7
UK	59131	2.7	197	2559.9
USA	574070	4.0	1368	65896.0

Notes:

Defence spending data for Australia, China, India and Sweden are in 2008 prices: source SIPRI (2011).

Data for NATO nations is provided from one source and is on a consistent basis.

Defence R&D data are in US\$ millions 2000 prices and PPP rates.

NA is not available.

Sources: NATO (2010); OECD (2010); SIPRI (2011).

Technical Spin-Offs

Defence R&D can also contribute to wider economic benefits in the form of technical spin-offs and spill-overs (external benefits : positive externalities

or external economies). Among numerous examples are: jet engines, avionics, radar, composite materials, the internet, and the application of helicopter rotor blade technology to wind turbines. These positive externalities might be regarded as part of the benefits of defence investments contributing to defence output that need to be included in a military cost-benefit analysis. But such views need to be assessed critically. Technology spin-offs are not the main aim of defence spending which primarily seeks to provide peace, protection, and security. Any technical spin-offs can be regarded as a windfall benefit of defence spending. Moreover, a list of spin-off examples fails to address the central question of the market value of such spin-offs, and whether there are better alternative uses of defence R&D resources. Consideration also needs to be given to the wider economic impacts of defence spending.

Defence-Growth Relationships

A considerable literature has developed on the relationship between defence spending and the benefits to a nation's economic growth. There are two alternative hypotheses. First is the view that defence spending favourably affects an economy's growth rate (a positive impact: Benoit 1973). Second is the contrasting hypothesis that military expenditure adversely affects a nation's growth rate (a negative impact: Deger and Smith 1983). Some of the literature has widened the possible relationship to include the impact of defence spending on other macro-economic variables such as employment, unemployment, inflation, exports, and R&D (Hartley 2010a).

Both hypotheses are dominated by myths, emotion, and special pleading. Plausible explanations can be provided for either a positive or negative impact of defence spending on growth, and there is evidence supporting both! The divergent results reflect the need for a properly specified model of economic growth. Typically, defence spending is simply added to a conventional growth model without careful consideration of its causal impact on growth.^{vii}

A considerable literature has used Granger causality tests to examine the relationship between military spending and the economy. A critique of this literature concludes that parameters may not be stable over different time periods, different countries, and that:

Granger causality test statistics are uninformative about the size and direction of the predicted effects and Granger causality measures incremental predictability and not economic causality (Dunne and Smith 2010, 440).

This particular critique ends with the need to provide “*measures of the political and strategic determinants of military expenditures, such as threats*” (Dunne and Smith 2010, 440).

IV. Assessing Defence Outputs: Problems and Challenges

Defence outputs involve a complex set of variables concerned with security, protection, and risk management, including risks avoided, safety, peace, and stability. Private markets routinely provide benefit measures such as sales, labour productivity, and profitability. Unlike private markets, there are no concise benefit measures for defence output.

Defence inputs are more easily identified, measured, and valued than outputs as reflected in many nations’ annual input-oriented defence budgets. For economists, questions then arise as to whether annual defence budget information provides sufficient data to assess the efficiency and effectiveness of military expenditure: How do expenditures on inputs correspond to desired defense outputs? Do defence budgets provide policy-makers and politicians with the sort of data needed to conduct military cost-benefit analyses?

Questions could include assessing the benefits and costs of alternative defence forces; expanding (or contracting) the Army, Navy, or Air Force; substituting equipment (capital) for military personnel (labor); or substituting national guard and reserves for regular (active) forces. Various defence budgets used by nations include: input budgets, output budgets, management budgets, and resource accounting budgets.

Input Budgets

Input budgets provide some limited information on defence inputs such as the pay of military and civilian personnel, as well as the cost of land, machinery, and internal financial transactions, such as write-offs of various types of losses (see Table 3.2). The information in Table 3.2 and particularly the first 10 items show the inputs used by the Canadian Department of National Defence (DND) in the production of national security outputs. More than half of the budget is spent on personnel, but there is no information on the proportion dedicated specifically to civilian, regular, and reserve personnel. The last two items referred to as Transfer and Subsidies, detail payments in the form of grants and contributions to various national and international organizations, capital assistance (subsidies) to industry, research grants, and other assistance towards research carried on by non-governmental organizations. These might be considered as intermediate outputs.

Crucially, however, such budgets have major limitations for assessing efficiency. First, the budget fails to show any final defence outputs other than under the vague heading of ‘defence.’ Second, it does not relate inputs to specific intermediate outputs (e.g. air defence; anti-submarine defences). Third, inputs focus on the current year only and do not reflect life-cycle cost implications of current procurement decisions. Fourth, inputs are not always valued in terms of market values. For example, some resources such as military bases and land for training might have been purchased years ago and are assumed to be free or available at a zero price, while other resources such as conscripts are not priced at their true labour market values. These and other limitations led to the development of output budgeting (Hartley 2011).

Table 3.2 Annual Defense Expenditures FY 2012-13 CDN\$000

Personnel	10,438,096
Transportation and Communications	768,058
Information	13,666
Professional and Special services	

	2,982,038
Rentals	383,972
Purchased Repair and Maintenance	1,465,091
Utilities, Materials and Supplies	1,017,831
Construction and/or acquisition of land, buildings and works	500,631
Construction and/or acquisition of machinery and equipment	2,434,609
Transfer payments	181,705
Total Subsidies and Payments	221,561
TOTAL GROSS EXPENDITURE	20,407,258
Total of Revenues	429,068
TOTAL NET EXPENDITURES	19,978,190

Source: Public Accounts Volume II. Receiver General of Canada (RGC-2013)

Output Budgets

Output budgets, also known as programme budgets, are much closer to the economist's production function model of defence budgets (Hitch and McKean 1960). Together with their costs, they provide information on some intermediate outputs of defence such as nuclear strategic forces, air defence, aircraft carriers, infantry regiments, and reserve forces. Output budgets also provide information on substitution possibilities (e.g. between nuclear and conventional forces and also between reserves and regulars).^{viii}

There are at least two major limitations with output budgets. First, the expenditure figures used in output budgets are unlikely to be least-cost solutions due to lack of competition and market incentives. Second, whilst they are known as output budgets, there remains a problem in identifying the overall output of defence. Often, outputs are defined in terms of the numbers of military personnel, aircraft squadrons, warships, and infantry regiments. These published data, however, are measures of intermediate, rather than, final outputs such as protection, security, safety, peace, and stability.

For example, the quantity of military personnel can be a misleading measure if training, productivity, and readiness for operations is ignored.

Similarly, the numbers of aircraft, tanks, and warships are misleading without data on their average age and their operational availability. Also relevant are the combinations of military personnel and equipment required for effective forces with an ability to be deployed and sustained in different overseas locations for long periods.

Management Budgets

Management budgets attempt to focus on efficiency. Top level and lower level budget holders are identified and awarded cash budgets where delegated financial powers allow military commanders and managers to combine resources to achieve agreed objectives. Inevitably, however, there are problems with management budgets. Budget holders (e.g. commanders of bases and units) often face constraints on their freedom to vary the mix of inputs of capital and labour (equipment and personnel). It is not unknown for large items of expenditure to be pre-committed, leaving base and unit commanders with choices about relatively minor items of expenditure (e.g. window cleaning, catering, and transport).

Efficiency incentives are also reduced if cost savings are automatically transferred to the Defence Ministry or the National Treasury. Nor can efficiency be achieved without clearly specified defence output targets. Cost savings can always be realised by reducing the quantity and/or quality of output, especially if output targets are not clearly specified!

Resource Accounting and Budgeting (RAB)

The U.K. adopted Resource Accounting & Budgeting (RAB) in 2002 in order to bring public sector accounting practices into line with those in the private sector. The key take away from RAB is that costs are accounted for as they are incurred (as with “accrual accounting”) rather than when payments are made (Table 3.3).^{ix} There is an annual balance sheet for the Ministry of Defence (MoD) showing fixed and current assets, provisions, and liabilities. Data on the value of the MoD’s fixed assets includes valuations for fighting equipment and the defence estate (e.g. military bases and land for training). By revealing the costs of holding assets, RAB provides incentives for efficiencies such as the disposal of surplus spare

parts, land, bases, and even estates. A Canadian Department of National Defence (DND) example of RAB and output budgets, known as Program Alignment Architecture (PAA), is provided in APPENDIX 1.^x

Table 3.3 MoD Resources by Budget Areas Current £ millions (2011)

Top Level Budget Holders	FY 2010-11
Departmental Expenditure Limits (DEL)	48 463
Request for Resources 1: PROVISION OF DEFENCE CAPABILITY	44 516
Resource DEL	36 221
Commander-in-Chief Navy Command	2 294
General Officer Commanding (Northern Ireland)	*
Commander-in-Chief Land Forces	7 189
Air Officer Commanding-in-Chief RAF Strike Command	*
Commander-in-Chief Air Command	2 826
Chief of Joint Operations	480
Defence Equipment & Support ⁵	16 869
Central	2 401
Defence Estates	2 136
Administration	2 026
Capital DEL	8 295
Request for Resources 2: CONFLICT PREVENTION	3 946
Resource DEL	2 862
Capital DEL	1 084
Annually Managed Expenditure (AME)	7 881
Request for Resources 1: PROVISION OF DEFENCE CAPABILITY	6 918
Request for Resources 2: CONFLICT PREVENTION	28
Request for Resources 3: WAR PENSIONS & ALLOWANCES, etc	935

Source DASA 2011

The adoption of private sector management and accounting practices such as RAB or PAA by themselves will not lead to overall efficiency in the MoD. The private sector has a range of mechanisms and incentives for achieving efficiency, including competition, the profit motive and the capital

market with the threat of take-overs and bankruptcy. Such mechanisms and incentives are absent from the MoD (and most other public agencies).

All parts of the public and private sectors consist of individuals and groups with incentives to pursue their own self-interests (recall the principal-agent model). The task for the MoD is to provide efficiency incentives equivalent to those in the private sector. Here, the challenge of measuring defence output remains a serious obstacle to assessing efficiency in the defence sector.

Both the U.K. RAB and the Canadian PAA are necessary steps towards connecting outcomes and resources but they require modifications and refinements. Both describe processes that tend to equate inputs to outputs. “Administration” in RAB and “Internal Services” in PAA are catch-all activities that include fixed costs and outputs (see Tables A1.3 in APPENDIX 1). For example, government-wide initiatives on accountability and environmental stewardship, while important do not link directly to security outputs. In order to make both RAB and PAA more relevant for the assessment of MoD’s and DND’s efficiency and effective management of resources, the re-design must be linked to a strategic planning framework and costing tool that displays the total ownership cost resources (Solomon et al. 2008).

Challenges

Two growing pressures make it essential to focus on the size of a nation’s defence budget and the efficiency with which defence resources are used. The first pressure is to reduce defence budgets and re-allocate resources to other public spending programmes, especially education, health, and welfare (including care for the increasing elderly populations). Second, added pressure on defence budgets comes from the increasing costs of defense equipment. A simple example shows the importance of rising unit equipment costs which affects all nations (all figures are for unit production costs in 2010 prices):^{xi}

- Spitfire unit costs (1940): £154,850
- Typhoon unit costs (2010): £73.2 million

- Typhoon replacement in 2050: £1+ billion

Increasing unit costs and constant or falling defence budgets (in real terms) suggest difficult defence choices cannot be avoided. The challenge in divestment discussions as in investment decisions is to establish useful measures of defence outputs, or in the absence of such measures, to develop proxies to enable cost-benefit analysis.

This chapter identified multiple issues and obstacles involved in developing defense output measures; it next reviews the experience of several nations. Many chapters in this book offer valuable techniques to develop proxy measures of intermediate outputs at lower levels of the organization in support of military cost-benefit analysis.

V. Defining Defence Outputs: The Benefits of Defence

In principle, defence provides an output in the form of goods and services which offer a stream of current and future benefits to a nation's citizens and to the citizens of other nations who might also receive such benefits. The benefits are both economic and non-economic. The economic benefits of defence usually take the form of services which contribute to national output. The non-economic benefits of defence include foreign policy benefits, peace-keeping, and its contribution to a nation's 'feel good' factor. This includes its involvement in being a responsible international citizen and valued member of the international community.

Economists rarely address the concept of overall defence output apart from vague references to security. Government statisticians and the National Accounts have traditionally measured defence output on the convention that output equals input (ONS 2008). Improving this limited measure requires that the concept of defence output be further developed and explored.

Security

In principle, defence provides security which is a multi-product output embracing protection, safety, insurance, peace, economic stability, and risk avoidance or reduction (Solomon et al. 2008). Further dimensions include prosperity, individual and national freedoms, liberty, and a 'way of life.'

These are all difficult to measure and might be influenced by factors other than defence. Also, these aspects of security are public goods which are not marketed and include non-marketable services involving no tangible and physical products.

Security is sometimes defined as the absence of threats or risks (Baldwin 1997; Engerer 2011). A world of no threats or risks, however, does not and cannot exist: The real world is characterised by continually emerging threats and risks. Questions then arise about which threats and risks can be reduced, by whom, and at what cost.

Recent developments have led to security referring to issues other than military security (creating fuzzy boundaries). Individuals are faced with threats to their lives, health, property, other assets, and their prosperity (e.g. from criminals and terrorists, disease/pandemics and ill health, natural or man-made disasters, and economic recessions). Threats to individuals augment the threats to nation states (e.g. military threats from other nations and environmental problems originating from other nations) which raises questions about which threats should be handled privately and which publicly.

Where threats are handled publicly, which is the most appropriate and least-cost solution? For example, military solutions are appropriate for external military threats whilst internal police forces are more appropriate for internal threats from criminals (e.g. physical violence to individuals involving injury, death, and robbery). Threats to an individual's state of health require dietary, medical, and care solutions (e.g. from doctors, nurses, and care homes). Threats to prosperity require government macro- and micro-economic policies to promote full employment and economic growth (e.g. opportunities for education, training, and labour mobility—although some of these activities can be funded privately).

Technical progress and changing consumer preferences have resulted in shifts from the public provision of security to private protection measures provided and financed by individuals (e.g. private security guarding, camera surveillance of property, and creation of neighbourhood watch schemes

providing local club goods). Security also has important geographical dimensions.

For example, defence can be viewed as a means of protecting a nation's property rights over its land, sea, and air space. A nation's defence forces, however, might also be used to protect other nations' citizens so that the public good becomes international which further increases the problem of obtaining and financing the optimal amount of the international public good (including peace). Overall, security measures can be analysed as national or international public goods, club goods, and private goods—each with different solutions and each embracing different industries (e.g. security and defence industries: Engerer 2011). These different industries have different customers, products, and technologies (Sempre 2011).

The Economic Benefits of Defence

Defence contributes to individual and collective security and protection, both of which are valuable commodities. It protects households and their assets, firms and their assets, the national infrastructure, national institutions, and national freedoms (e.g. democracy, freedom of speech and movement, etc). It also protects national interests, including independence and 'appropriate sovereignty' (e.g. protecting a nation's interests in a globalised world, including leverage and status in world politics and diplomacy). How can these commodities be valued? There are at least three approaches.

First, estimate a nation's per capita defence spending and then ask whether its citizens are willing to pay at least such a sum for the annual protection offered by its Armed Forces. Comparisons can be made with other public spending programmes, such as health and police forces. Second, value-of-life studies can be used to estimate the valuation of lives saved and injuries avoided resulting from the provision of Armed Forces (See Chapter 9, and Jones-Lee 1990).^{xii}

Health economists have developed measures of health output benefit measures in the form of quality-adjusted life years or QALYS (but these are not valued). The defence equivalent of QALYS would be protection-adjusted life years (PALYS: Hartley 2010b). In addition to estimating the

benefit of lives saved from defence, there are further gains from valuing property saved by avoiding damage and destruction (i.e. estimating both human and physical capital saved).

Third, consider defence as insurance in response to various current and future known and unknown threats and contingencies. These contingencies can involve time-periods of some 25–50 years into the future: The result lags in the relationship between inputs and defence outputs meaning that defence productivity cannot be based on the standard relationship between inputs and outputs within a calendar year. The insurance approach has private market comparators. Individuals and firms pay for a variety of insurance policies and other forms of protection. Examples include households buying insurance for homes, motor cars, driving, health care, international travel, and retirement.

In addition, households buy further protection in the form of household security (e.g. alarms and guard dogs), purchasing safer motor cars, locating in a safe neighbourhood, and joining neighbourhood watch schemes (through payments-in-kind). Similarly, firms make various insurance payments for protecting their assets: They employ security guards and introduce measures to protect their staffs and assets from terrorist attacks. Admittedly, these are private rather than public goods but, nonetheless, the payments in cash and kind provide some indication of the willingness of households and firms to pay for protection; such willingness to pay might then be applied to estimating the minimum level of a nation's defence spending. Further spending for protection is reflected in expenditure on a nation's police forces and internal security. The result is a substantial expenditure for private and public spending on internal security. Again, such sums provide an estimate of the lower bound of national defence spending.

By providing security and protection for a nation's citizens, defence spending on the Armed Forces create the conditions allowing and promoting beneficial voluntary trade and exchange within and between nations. Protection of national property rights over land, sea, and air space (and more recently cyber-space) promotes national market exchanges whilst protection of international trade routes promotes beneficial international trade and

exchange. For example, a nation's Navy protects its international shipping and trade routes, including protection from piracy.

National and international market exchange contributes to improve society's welfare (e.g. especially compared to societies that lack well-developed national markets). In the context of national markets, the Armed Forces provide a capability to respond to national emergencies and provide aid to the civilian community. Without the Armed Forces, civil powers would have to provide more resources for emergencies (a relatively high cost for capabilities only required infrequently), or ignore such contingencies.

Ideally, defence spending on a nation's Armed Forces helps prevent and avoid conflict; and where conflict occurs, minimises its duration and effects on citizens, as well as contributing to more rapid post-conflict recovery. In this context, defence provides a deterrent aiming to persuade potential adversaries that conflict is not worthwhile. Where deterrence fails, defence spending aims to provide a warfighting capability to achieve a 'successful' conclusion by minimising the costs of conflict.

These features are economic benefits that can be reflected in cost savings from avoiding conflict or minimising its duration, and contributing to post-conflict recovery and restoration of market activity. Again, it is difficult to measure cost savings for events which do not occur. Indeed, such problems raise the general methodological issue of the counter-factual: What would have happened in the absence of defence spending?

Defence spending as a form of fiscal policy provides some direct national economic benefits comprising jobs, new technology, spin-offs, exports, and import-savings. The Armed Forces are a source of employment, and their spending in local areas further increases employment and provides a source of trained and skilled labour for the rest of the economy. In addition, public spending on the nation's defence industrial base contributes to jobs, advancing technology, spin-offs, and the balance of payments.

As discussed earlier, however, these economic benefits need to be assessed critically: There are serious doubts about many of these claimed

economic benefits. For economists, a major concern arises over the alternative-use value of the resources employed in the Armed Forces and national defence industries. It needs to be asked whether the resources used in the military-industrial complex would make a greater contribution to jobs, technology, spin-offs, and exports if these resources were used elsewhere in the economy (Hartley 2010b).

Bilateral military alliances might provide additional economic benefits. For example, the U.S.-U.K. special relationship provides the U.K. with access to U.S. technology for its nuclear-powered submarines and missiles for its nuclear deterrent; with a leading role in the F-35 programme; and enables major U.K. defence firms' access to the U.S. defence market (e.g. BAE and Rolls-Royce). Also, the U.S. provides security and protection for the U.K. which might otherwise require a larger defence budget. Similarly, Canada benefits from U.S. defence spending and protection, leading to lower Canadian defence spending.

Non-Economic Benefits of Defence

Defence spending also contributes major non-economic benefits to a nation and it might be that non-economic benefits are more valuable than many economic benefits. Non-economic benefits are those which do not explicitly contribute to national output. They comprise political, military-strategic, and international benefits.

These non-economic benefits include the ability to pursue national interests and foreign policy objectives; to add to a country's international reputation, standing, and status in the world (the feel good factor); and to increase its position in the world power hierarchy. These non-economic benefits might be reflected in a nation's position in the United Nations (e.g. membership of the Security Council), its membership in world economic organisations (e.g. OECD, IMF; G-8, and G-20 groups of nations), its leadership positions in international military alliances (e.g. NATO), and its ability to influence the behaviour of other nations. For example, military-strategic benefits can arise from bilateral or multilateral military alliances

(e.g. benefits from standardisation of equipment and tactics; some of which are economic in the form of cost-savings).

A nation can obtain further non-economic benefits in the form of:

- **Prestige and international reputation:** by providing military forces for international peace-keeping and peace enforcement, leading to world peace. Such peace-keeping contributions, however, are not costless.
- **Feel good factor:** Further non-economic benefits arise where a nation's Armed Forces contribute to international efforts on humanitarian aid and disaster relief. These contributions provide a 'feel good' factor (national pride) for the contributing nation's citizens (e.g. national spending on child protection and social services: Hartley 2010b).
- **Compulsory Club Membership:** Some nations may contribute to peace missions because they value (or feel compelled by) a relationship with a dominant ally or neighbour. This type of alliance or relationship can be considered as a compulsory club membership with clear obligations and benefits (Berkok and Solomon 2011).

VI. The Evidence: The International Experience with Measuring Defence Output

United Kingdom (U.K.) Experience

Before 1998, the U.K. published traditional input and intermediate measures of defence output. Typically, these comprised numbers of Armed Forces military personnel and their formations, including numbers of aircraft squadrons, infantry regiments, tank units, and warships. The published data on unit numbers was available in varying degrees of detail (e.g. aircraft squadrons by types of aircraft, types of warships, etc). The amount of published data and its detail has improved over time. Data was also published on the numbers of regular and reserve forces and the numbers of civilian personnel employed by the Ministry of Defence (MoD).

During the Cold War, the Armed Forces focused on preparing for and deterring a direct military attack on the U.K. or Western Europe. After the Cold War, there was no longer a direct military threat to the United Kingdom. In 1998, the publication of the Strategic Defence Review (SDR) marked a significant change in published defence output measures.

The 1998 SDR represented a pioneering contribution to U.K. published data on defence output measures. For the first time, the U.K. published data on its defence capabilities which are a more meaningful indicator of defence output. These defence capabilities are viewed as planning commitments. The 1998 SDR committed the U.K. to be a ‘force for good’ in the world with an associated global military expeditionary capability. On this basis, the U.K. Armed Forces were capable of supporting continuing commitments (e.g. Northern Ireland at that time) able to:

- Respond to a major international crisis of a similar scale and duration to the Gulf War (an armoured division, 26 warships, and over 80 combat aircraft), or,
- Undertake a more extended overseas deployment on a lesser scale (e.g. Bosnia) while retaining the ability to mount a second substantial deployment if this were made necessary by a second crisis (e.g. combat brigade and supporting air and naval units).^{xiii}

These defence capabilities were subject to various constraints of readiness, location, duration, and concurrency. Different levels of readiness involve different cost levels: Maintaining continual high readiness is costly. Similarly, location and duration affect force requirements: Regional conflicts outside the NATO area and for an indefinite duration require different sizes and structures of Armed Forces compared with short-term deployments to, say, Bosnia or Kosovo.

Concurrency is a further issue involving the number of operations which can be conducted at any time involving their scale, location, and duration. SDR identified the core regions of Europe, the Gulf, and the Mediterranean. The U.K. was committed to conducting two medium-scale operations

concurrently (SDR 1998). Surprisingly, the government's actual military commitments exceeded these planning assumptions!

Following the 9/11 terrorist attacks on the U.S., the 1998 SDR was modified. A modified policy was announced in 2003/04 (comprising Cmnd. 6041 2003; Cmnd. 6269 2004). The revised policy adopted new planning assumptions including:

- The ability to support three simultaneous small to medium-scale operations where at least one is an enduring peace-keeping mission (e.g. Kosovo),^{xiv} or
- The ability at longer notice to deploy forces for large-scale operations while running a concurrent small scale peace support operation, or
- The ability to project military force to sub-Saharan Africa and South Asia as well as a capability to respond to international terrorism.
- The most demanding operations will be conducted as part of a coalition, usually involving the U.S. This requires the U.K.'s Armed Forces to be interoperable with U.S. Forces.^{xv}

Further changes occurred with the Strategic Defence and Security Review of 2010 (Cmnd. 7498 2010). Following the 2010 planned budget cuts, the U.K.'s Defence Planning Assumptions and its defence capabilities were reduced to:

- An enduring stabilisation operation around brigade level (up to 6500 personnel) with air and naval support; and,
- One non-enduring complex intervention (up to 2000 personnel) and,
- One non-enduring simple intervention (up to 1000 personnel), or,
- Alternatively, three non-enduring operations if not already engaged in an enduring operation or,
- For a limited time, and with sufficient warning, committing all the U.K.'s effort to a one-off intervention with up to three brigades with air and naval support (about 30,000 personnel),^{xvi}

- Maintaining a ‘residual defence capability’ for unforeseen emergencies or to reinforce existing operations or to respond to scenarios where the U.K. acts alone (House of Commons (HCP) 992 2011, 20).

MoD budgets pay for the U.K. force elements to be ready for operations as outlined in the Defence Planning Assumptions. The costs of these missions, however, are funded from the Government’s Contingency Reserves. Over time, the rising unit costs of defence equipment and of volunteer military personnel will result in smaller Armed Forces and reduced defence capabilities (as defined by the U.K. MoD).

More important would be an assessment of the costs of achieving these defence capabilities compared with other nations providing similar capabilities (i.e. is the U.K. providing its capabilities at least-cost?). Within MoD, measures of defence training activities are used to assess performance. These include flying hours, days spent at sea, and Army personnel data on gains to trained strength and data on military exercises (ONS 2008).

The MoD publishes an annual performance report which offers some further insight into its defence capabilities (HCP 992 2011).^{xvii} Useful though such information might be, it is both qualitative and vague (i.e. “success” in Afghanistan) and focuses on input costs which are unhelpful data for measuring output by themselves. On force readiness, the MoD’s Performance Report admits that “Measuring and aggregating readiness is complex, not least because it is based on judgements of what is required to enable the Armed Forces to respond to a wide range of potential challenges”(HCP 992 2011, 21).

The MoD also reports on where there are ‘critical and serious weaknesses’ in U.K. Forces.^{xviii} The MoD’s Performance Report also included a section on implementing the 2010 Strategic Defence and Security Review which provided further information on the U.K.’s defence capabilities.^{xix}

The U.K.’s defence capabilities output measures are an improvement on the traditional input approach but there are deficiencies at least in terms of

publicly available information. For example, the National Audit Office has reported that the U.K. MoD has a good system for defining, measuring, and reporting the readiness of its Armed Forces which compares well with other countries (e.g. Australia, Denmark, and U.S. from NAO 2005). It is recognised that 100% readiness is too costly. The published data on readiness, however, refers to whether there are serious or major weaknesses, which is useful but not very illuminating (e.g. without knowing what and where such weaknesses arise and their impact on force effectiveness). For instance, a statement that 50% of U.K. Forces had no serious or critical weaknesses suggests the remaining 50% suffered serious weaknesses which should be a source of concern!

Moreover, these performance assessments are mostly undertaken by MoD personnel, which could raise questions of independence and objectivity. A National Audit Office Report on the performance of MoD in 2009–10 presented and reviewed performance indicators (NAO 2010). The report focused on financial management information (e.g. management of stocks and assets) and made no mention of defence output measures. Though there was mention of defence output indicators, these only included qualitative measures: ‘success on operations;’ the existence of serious and critical weaknesses in readiness; manning levels in relation to manning balance by Service (with no data); and flying hours achieved against targets (again, without any data). In relation to the MoD aim of global and regional reductions in conflict, no output measure was reported by the National Audit Office (NAO 2010).

The National Audit Office also publishes value-for-money reports (a type of retrospective cost-benefit analysis), for example, on the multi-role tanker aircraft capability, and annual reports on MoD’s major projects. These project reports assess major defence projects against their contractual commitments on cost, delivery, and performance usually identifying cost overruns, delays, and any failures to meet performance requirements. Such value-for-money reports are a useful addition to knowledge but do not include wider industrial and economic benefits of major projects, nor do they provide any assessment of the ‘battle-winning’ performance of defence equipment (e.g. as demonstrated in conflicts such as Afghanistan or Iraq).

Overall, the U.K.'s defence capabilities are useful measures of defence output but deficiencies remain. Some indicators of force readiness are qualitative: readiness is a variable measure depending on circumstances (readiness for what, when and where?); capabilities are not all identified; benefit values are not attached to capabilities; and the capabilities cannot be aggregated into a single measure of overall defence output.

None of the output measures address the contribution of defence to conflict prevention and its contribution to minimising the costs of conflict, including saving lives. In fact, MoD economists examined different approaches to capturing output used in various parts of the MoD. "These include a number of partial aggregations and a balanced scorecard approach covering the three main areas of activity: success in military tasks, readiness to respond, and preparing for the future...and...it was confirmed that no existing technique offered a solution. Although it is hoped that in the longer term progress will be made on the direct measurement of defence outputs and productivity, this remains an elusive goal" (Davies et al. 2011, 399).

(Note: APPENDIX 2 examines the U.K.'s experience in measuring outputs in other parts of the public sector and in the private sector, offering selected insights for defense).

Australian Experience

The Defence White Paper of 2009 outlined Australia's defence policy and force structure to 2030 (DoD 2009). It specified Australia's strategic interests including (ranked in order of priority):

- The defence of Australia against armed attack with the capability to act independently so as not to be reliant on foreign military forces. This principal task requires the Australian Defence Force (ADF) to control the air and sea approaches to Australia;
- The security, stability, and cohesion of Australia's immediate neighbourhood which is shared with Indonesia, Papua New Guinea, East Timor, New Zealand, and the South Pacific Island states;

- An enduring strategic interest in the stability of the wider Asia-Pacific region; and
- A strategic interest in preserving the world international order which restrains aggression, manages other risks and threats, and addresses the security impacts of climate change and resource scarcity.

These objectives are to be achieved by Australia acting independently, by leading military coalitions, and by making tailored contributions to military coalitions. As a result of these priorities, the ADF of 2030 will need to invest especially in its maritime capabilities as well as enhancing its air capabilities.

Part of the funding for these capability improvements is to be achieved through efficiencies and savings (of AUD \$20 billion) which, it is claimed, will not compromise effectiveness (DoD 2009, 14). Also, to fund ADF of 2030, the Government has committed to real growth in the defence budget of 3% to 2017–18 and then 2.2% real growth to 2030 (DoD 2009, 137). The 2009 White Paper recognises that defence planning is about managing strategic risks, that uncertainties remain, and that it is not possible to eliminate all risks (an ideal warning time of 10 years is reported: DoD 2009, Chapter 3, 28).

The 2009 White Paper deals with preparedness embracing readiness, sustainability, and concurrency. It recognises that preparedness comes at a cost (but provides no data on the marginal benefits or costs of different levels of preparedness). Sustainability refers to the ability to undertake tasks and operations over time, whilst concurrency deals with the ability to conduct a number of operations in separate locations simultaneously. The White Paper provided an extensive list of the required capabilities of the ADF including:

- The capabilities needed for sea and air control around Australia;
- Deploy a brigade group for combat operations for a prolonged period of time in the primary operational environment (for shorter period beyond that area);

- Deploy a battalion group to a different area of operations in the primary operational environment;
- Maintain other forces in reserve for short-notice, limited warning missions;
- Provide tailored contributions to operations in support of Australia's wider strategic interests (e.g. special task forces group);
- Provide assistance to civil authorities (e.g. fisheries protection, terrorist incidents, support for major events, emergency responses, humanitarian and disaster relief in Australia and its neighbours, provision of search and rescue support, etc).

The list of capabilities is extensive with no ranking and little indication of the military resources available for each capability. Some of the capabilities are clearly military; others, including aid to civil authorities, are a general 'catch-all' which might be used to justify public support for defence spending. Further data on capabilities is provided by the annual defence budget.

Australian defence budgets show published data on expenditure on various overseas operations—the sources of planned cost savings, and capital investment programmes. There is data on the extra costs of overseas operations and on the numbers of military personnel by service (permanent, reserves, and numbers of high readiness reserves). Further budget data is presented on planned performance and outcomes for each of three defence outcomes comprising the protection and advancement of Australia's national and strategic interests and support for the Australian community and civil authorities (including expenditure by military base area). Some limited performance (intermediate output) indicators are published such as the number of unit ready days for the Navy and flying hours for each of the services (DoD 2011).

A review of defence accountability was published in 2011 with the aim of improving accountability across defence (Black 2011). The review recommended the introduction of specific, measurable, and achievable outcomes with individuals given ownership and made accountable for their outcomes. The review recognised that there was a lack of specific outcome-

based language in defence and an insufficient use of measurable outcomes. Particular focus was placed on performance measures for shortfalls in equipment delivery to date, including costs and quality (e.g. average delays of 28% or 2+ years; cost overruns of 52%: Black 2011, 60–61). The review, however, focused on management-organisational issues (e.g. too many committees) and not on the development of defence output measures and their consequences.

In June 2011, the Australian Minister for Defence announced a Defence Force Posture Review designed to assess whether the Australian Defence Force (ADF) is correctly positioned geographically to meet Australia's modern and future strategic and security challenges. These include:

- The rise of the Asia-Pacific and the Indian Ocean rim as regions of global strategic significance;
- The growth of military power projection capabilities of the Asia Pacific countries;
- The growing need for the provision of humanitarian assistance and disaster relief following extreme events in the Asia Pacific events; and
- Energy security and security issues associated with expanding offshore resource exploitation in Australia's North West and Northern approaches.

The ADF Force Posture Review considers how the ADF will support Australia's ability to respond to a range of activities including deployments on overseas missions and operations; support of operations in Australia's wider region; and engagement with the countries of the Asia Pacific and Indian Ocean rim in ways which will help to shape security and strategic circumstances in Australia's interest. The Force Posture Review also makes recommendations on basing options for Force 2030. There is also a Submarine Sustainment Review to assess sustainment of Australia's Collins Class submarines (ADF 2011).

The Australian Defence White Paper of 2013 identified the capabilities the ADF will need in the future, reflecting the withdrawal from Afghanistan

and the Solomon Islands. It emphasised air, naval,^{xx} special-forces, intelligence, and cyber security. The commitment to spending 2% of GDP on defence became a long-run target.

The 2013 White Paper presented a broad description of future forces but provided little detail on their capabilities. Interestingly, the 2013 White Paper referred to productivity and the need for “defence to become more efficient and prudent in its use of resources to remove waste and achieve better economies of scale.” This is a politically attractive phrase, but does not explicitly address the challenge of preserving an adequate level of overall defence output and corresponding measurement challenges.

New Zealand Experience

New Zealand has a considerably smaller defence effort compared with the U.K. (see Table 1; Hartley 2010b). Nonetheless, it has devoted substantial resources to measuring its defence output. This section describes and assesses the development of its output indicators as published in 1991, 1993, 2011, and 2013.

In 1991, the New Zealand Defence Force (NZDF) published defence output measures in its Annual Plan (NZDF 1991). At this time, the output of the NZDF was grouped into two main categories: namely, retained outputs and current outputs.

Retained outputs are military groupings of operational forces which are retained to provide the Government with a basis of military power from which force may be applied. Current outputs reflect the range of current activities undertaken by the NZDF which reinforce foreign policy goals and contribute to the well-being of the nation. Current outputs were further divided into core (military activities which contribute to military outcomes) and non-core (services provided to the community).

Published intermediate output data was provided for the two final outputs. For example, retained outputs consisted of eleven intermediate outputs: namely, naval combat forces; mine countermeasure forces; naval control and protection of shipping organization; strategic assets (force

troops); ready reaction forces; infantry brigade group and force maintenance; long-range maritime patrol force; offensive air support force; long and medium-range air transport force; medium and short-range air transport force; and the utility helicopter force.

Each intermediate output included performance targets and performance achievements. For example, the performance target for the infantry brigade group required deployment for operations within 90 days, and the performance achieved was for such a force to be available for sustained low-level operations at 90-days' notice. Offensive air support required 3,760 flying hours by Skyhawks, but there was a shortfall of over 400 hours against this target.

Changes were made and announced in 1993 (NZDF 1993). Seven output classes were identified: protection of New Zealand's territorial integrity and sovereignty; provision of military advice; provision of intelligence; provision of ancillary services; contribution to regional security; mechanisms for participation in defence alliances; and contributions to collective security.

Each output class was divided into sub-groups, each with performance targets and achievements. For example, the sub-group of countering terrorism had a performance target of two counter-terrorist exercises but only one such exercise was conducted. Similarly, for the sub-group called deterring intrusions, there was a performance target of sustaining a naval presence for up to 30 days in the New Zealand area, and it was reported that this capability was demonstrated and achieved.

Whilst an impressive amount of detail was published, there are serious deficiencies with the outputs reported and performance indicators used. First, the outputs and performance indicators reported are mainly inputs or intermediate measures of output. Second, several outputs are unusual for defence outputs: namely, the provision of advice, intelligence, and ancillary services which includes civil defence assistance, support services to the community, and ceremonial support for the state. Third, the published data provide no weighting to indicate the relative importance of the various

intermediate defence outputs to overall security. Is the provision of advice and intelligence ranked as highly as protection of New Zealand's territorial integrity and sovereignty? Fourth, some defence outputs might more appropriately be the responsibility of other government departments.

The defence outputs were refined and developed over time and with experience. The New Zealand position in 2011 is reflected in the NZDF Statement of Intent (NZDF 2011) which outlined the country's defence policy over the next 25 years. It specified the primary mission of the NZDF as securing New Zealand against external threat, protection of its sovereign interests, and the ability to take action to meet likely contingencies in the country's strategic area of interest. This primary mission recognises that the country's national interests affect both the security and prosperity of the nation.

New Zealand must trade to survive which requires that New Zealand has unfettered access throughout the Asia-Pacific region to engage in business. "Instability, conflict and war, even far from New Zealand's shores, can therefore directly affect New Zealand's social and economic well-being" (NZDF 2011, 9). Recognizing that the primary mission of the NZDF is broad, a number of subsidiary or intermediate outcomes have been developed.

The NZDF main and intermediate outcomes are currently not linked to a formal set of measures, mainly due to the complexity of measuring outcomes which deliver security and protection: There is no single measure of success in delivering protection. "There is no definitive way of knowing what might have happened, but did not happen, because of the activities of the NZDF" (NZDF 2011, 34).

The NZDF has 37 outputs within 16 output/expenses classes. Its output/expenses classes include naval combat and support forces; mine countermeasures; land combat and support forces; naval helicopter forces; airborne surveillance; and fixed wing and rotary transport forces.

Other output categories include unusual components such as military hydrography, military advice, and multi-class output appropriations (e.g.

support to youth development and support to military museums: NZDF, 2011). The NZDF also stresses its links with the community reflected in the provision of skills to society, promotion of a ‘healthy’ defence industry, and a “buy New Zealand” procurement policy (NZDF 2011, 11). It is now explained, however, that these links to the community arise as by-products of the NZDF (NZDF 2011, 11).

The NZDF uses a measure of military capability which shows the combined effect that inputs have on operational effectiveness. Military capability is assessed using two elements: namely, preparedness and force components described by the acronym PRICIE.^{xxi} The elements are comprised of: Personnel; R&D; Infrastructure; Concepts of Operations and Training; Information/technology; and Equipment and Logistics (NZDF 2011, 48).

The NZDF recognises that its output measures often appear as inputs rather than outputs. Inputs are used as proxies for military capabilities (e.g. 500 flying hours of a specific type of aircraft will provide a certain military capability), but the actual measurement systems and capabilities are classified. Following the New Zealand Defence Review, however, concerns were expressed that the current system is too input-focused, amid a desire to measure military impacts and outcomes and cross-sector security outcomes. Where complex relationships are involved, it might not be possible to easily identify and measure cause and effect (CAG 2011). No valuations of output are provided.

These concerns continued in the NZDF Annual Report of 2013 which reported its aggregate level of preparedness as ‘substantially prepared’ (asserted without supporting data). The 2013 Report did publish some output measurements, including objectives, measures, and outcomes (NZDF 2013). Overall, the NZDF has made commendable efforts to recognise and address the challenge of measuring defence output.

European Experience

The focus here is on major European defence spending nations that publish their data in English. These nations are comprised of France, Germany, Italy, Spain, and Sweden.

France

A new French defence policy was announced in 2008 with the aim of making the French armed forces more flexible for rapid deployment from the Atlantic to the Indian Ocean. France aims to provide the necessary resources to ensure the security of its citizens, to safeguard national independence, and to consolidate the nation's military and diplomatic power. Under the new policy, France will be able to project 30,000 personnel with 70 combat aircraft, one carrier group and two naval battle groups within a six-month period for up to a year (a force capable of dealing with one major war or crisis at a time). Nuclear deterrence remains a key military mission, but terrorism is the most immediate threat, and there are also public service missions. There will be reductions in the numbers of military personnel and investment in new equipment. Some equipment is of poor quality: For example, only 50% of Leclerc tanks are mission ready; its refuelling aircraft are 45 years old; and some Puma helicopters are 30 years old (Penketh 2008). In 2010, the U.K. and France signed an Anglo-French Defence Treaty with the potential for greater bilateral co-operation between their armed forces and defence industries.

By 2014, French defence policy was adjusting to a 'difficult financial situation' leading to further reductions in the numbers of military personnel, ships, tanks, helicopters, and transport aircraft. A Joint Reaction Force was created with 2,300 personnel and the ability to deploy up to 15,000 troops in a single overseas deployment. Plans were in place to cut the defence budget to 1.5% of GDP.

Germany

NATO remains the centrepiece of Germany's defence policy. The new defence policy announced in 2011 involved major changes for Germany's armed forces: reductions in the defence budget; abolishment of conscription replaced by an all-volunteer force; improvement of Germany's

expeditionary capabilities; and closer military co-operation in Europe, especially in procurement and training (GMOD 2011). Under the new policy, Germany plans to increase the deployment of the Bundeswehr outside Germany from the current 7,000 to some 10,000 soldiers (but there is no statement of the extent of geographical coverage of these expeditionary forces). There are also plans to reduce quantities of equipment (aircraft, helicopters, and ships). In 2014, however, Germany announced a review of its commitment to overseas military deployments, including its military contribution to the international pooling and sharing of military resources.

Italy

Despite cuts in defence spending due to Italy's austerity programme, Italy retains an expeditionary capability. Reports suggest the Air Force has been particularly affected by defence cuts. There were also reports that in 2010, Italy planned to reduce its involvement in peacekeeping missions in the Balkans and possibly in Lebanon, concentrating instead on Afghanistan where force levels peaked at 4,000 soldiers (Nativi 2010).

Italy's Military Policy Review of 2013 aimed to reduce the numbers of military personnel to 150,000 and civilian personnel to 20,000 by 2024. This represents a lengthy adjustment period. Italy also identified reductions in the numbers of senior military personnel within the reduced total numbers (i.e. fewer admirals, generals, colonels, and navy captains). The plan is for a defence budget of 0.84% of GDP.

The 2013 Military Policy Review declared that "available resources will be used on developing systems that combine high operational efficiency, adequate cost-effectiveness, and a development/growth margin that allows them to be integrated into complex and net-centric systems."

Spain

Reductions in defence spending were part of Spain's austerity programme. The 2011 budget reflected four objectives: the safety of the troops (force protection via operating and logistics expenditure); operational readiness; the maintenance of weapons systems; and international operations

and fulfilment of Spain's international commitments. New tools were announced for improved oversight and management of defence expenditures.

Sweden

A new defence policy was announced in 2009 with an emphasis on mobility and flexibility of Sweden's armed forces. The plan is for an entire operational organisation of some 50,000 people to be used within one week after a decision on heightened alert. In contrast, today only one-third of the national operational organisation is equipped and prepared for an operation within one year. Some defence capabilities were listed in terms of inputs: numbers of military personnel (e.g. deployment of 1,700 people for continuous international peace-support operations) and numbers of Gripen aircraft (100 of the C/D model). An all-volunteer force will replace compulsory military service and there will be substantial reserve forces (e.g. four mechanised battalions). For the Army, only a small proportion of its soldiers will be full-time. Sweden specified its area of national interest: namely, the Baltic Sea or the northern area (SMOD 2009).

The European Defence Agency

The EDA publishes defence data for its Member States. These include annual financial data such as levels of defence spending and shares of GDP for Member States; equipment procurement and R&D expenditures; spending on infrastructure and construction; defence expenditure that is outsourced; and expenditures on collaborative equipment programmes. Input data is also published that includes numbers of military, civilian and internal security personnel, personnel expenditures, as well as data on numbers of different types of equipment (combat aircraft tanks and warships).

Most of the data published is for inputs rather than defence outputs, although some EDA officials regard indicators such as quantity of military personnel as intermediate output measures. There is, however, data which is clearly a measure of intermediate output and proxies for defence output: namely, operation and maintenance expenditure, operational costs, average numbers of troops deployed, and the average numbers of sustainable (land)

forces (EDA 2011). Comparative analysis of such data could be useful in revealing variations in efficiency and effectiveness across member states.

The United States

The U.S. is unique in its global power commitments and large-scale defence spending. U.S. national security strategy requires a “comprehensive global engagement aimed at supporting a just and sustainable international order” (USDOD 2011, 2–1). The U.S. remains the only nation able to project and sustain large-scale military operations over extended distances. Its main objectives are to prevail in today’s wars; prevent and deter conflicts; prepare for a wide range of contingencies; and preserve and enhance the all-volunteer force (AVF). Three of these objectives refer to actual and potential threats or outputs/outcomes, but the commitment to the AVF is an input, not an output! Funding for these objectives is to come partly from efficiency savings, including cancellation of unwanted and poorly performing equipment programmes.

The U.S. DoD publishes a massive amount of data of varying degrees of usefulness in terms of measuring defense outputs. For example, its aims include sustaining military capabilities to fight two wars, confront global terrorism, and provide humanitarian assistance and disaster relief, but no measures or valuations are attached to any of these objectives.

It also presents extensive data on performance results relating to its primary warfighting goals and its supporting goals (e.g. preserving the AVF and implementing the defense agenda). It is claimed that 75% of DoD performance goals were met in 2010 with 25% not met—winning our nation’s wars was apparently 100% met even though, at the time, the final outcomes in Afghanistan and Iraq were still unknown! Similarly, for defence of homeland security, it was reported that 67% of goals were not met, a surprisingly high failure rate for such a core defence function (i.e. protecting U.S. citizens: USDOD 2011, 7–11).

U.S. defence budget data only marginally enhances the understanding of defence outputs in terms of capabilities and valuations. Performance results are recorded by DoD staff who may have a not entirely unbiased interest in

reported outcomes. Budget data tend to be input-oriented, showing annual expenditure on military personnel, operations and maintenance, R&D and procurement, and family housing and military construction—all published by totals and by service.

The 2014 Quadrennial Defense Review described ‘tough choices’ being made in an era of fiscal austerity. These choices were reflected in a reduced force structure, modernising the forces, investing in readiness and innovation to meet future challenges, and protecting the health of the all-volunteer force in undertaking these reforms. Within this framework, the U.S. retained its capability to simultaneously engage in two regional conflicts.

Evaluating International Experience

In recent years, financial austerity played a major role in formulating defence policy, especially in the U.S., U.K., and the rest of Europe. It is under these constraints that measuring defence output can be particularly helpful in improving cost-benefit analyses to guide difficult defence choices. Unfortunately, the response to austerity often resulted in traditional across-the-board force reductions to accommodate politically determined budget choices. While the Armed Forces cannot ignore budget constraints in policy formulation, sensible policy choices require recognition of defence output implications of smaller budgets and the need to formulate better measures of defence output to guide future cost-benefit analyses.

VII. Conclusion

This chapter has identified a set of important questions that arise in efforts to measure defence outputs. Indeed, it has raised more questions than answers, but this investigation contributes to further understanding needed to address the central research questions: What is defence output? How can it be valued? Under what conditions is it a worthwhile investment?

In its published form, the international experience of measuring defence output reveals some useful intermediate output measures, usually in the form of specific defence capabilities.^{xvii} These are improvements on the traditional emphasis on inputs that have typically included numbers of military

personnel and equipment (e.g. combat aircraft, tanks, and warships). By themselves, input measures offer little indication of the value of overall defence capabilities such as peace, protection, deterring conflicts, and insurance against future threats.^{xxiii}

A starting point in answering the central research questions is to apply cost-benefit analysis: to identify the costs of defence and then ask whether defence provides at least a comparable level of benefits in the outputs produced. It is also important to capture non-economic benefits in addition to measurable economic benefits in measuring the overall benefits of defence spending. For example, if defence spending costs \$X billion, does it provide overall benefits of a similar value? Similar questions can be asked about the costs and benefits of conflict and peacekeeping operations.^{xxiv}

Next, the cost-benefit analysis can focus on incremental (or marginal) changes. If defence spending is increased or decreased by 10%, what are the effects on defence outputs (benefits)? Such marginal analysis can be assessed as a whole (on overall defense output), or by each military service (on intermediate defense outputs, e.g. what would be the impact of a 10% increase or decrease in the size of the Army?).

Specifying the important questions is the first stage in any evaluation; but who raises and answers the questions? In a democracy, elected politicians are ultimately responsible for determining the size of military expenditures and its allocation among each of the services. Typically, unelected agents within the military propose many of these choices.^{xxv} This reinforces the importance of developing meaningful defense output measures to guide future military investment and divestment decisions.

APPENDIX 3.1

The PAA is part of a broader government policy on managing resources and reporting results that directs all departments to have clearly defined and measurable Strategic Outcomes. DND's articulation is depicted in Table A3.1 and it intends to show what defence does and the results it is striving to achieve.

[INSERT 03_Chapter 3 Table A3.1: Canadian Program Alignment Architecture current CDN \$ 000.]

As shown in Table A3.1, strategic outcome 3 states that “Defence operations improve Peace, Stability and Security wherever deployed.” This statement is rather vague on the military capabilities required to achieve the outcome. Is this a peacekeeping or peace enforcement mission? Is it exclusively the provision of strategic lift to transport aid and soldiers or air patrol? How quickly could the Canadian Armed Forces (CAF) provide an effective fighting force for an operation in North America? The statement also asserts with certainty an outcome, without any probabilities attached (e.g. defence operations *might* improve peace, stability, and security).

The strategic outcome 4 which states “Care and Support to the Canadian Armed Forces and Contribution to Canadian Society” is equally ambiguous. The care and support to CAF members can be considered an input (part of recruitment and retention) while contribution to society could be a grant/subsidy program. Even if we make the assumption that outcomes and outputs are the same, there are still challenges in measuring the outcome/output. How do you measure international peace?

Table A3.1 Canadian Program Alignment Architecture current CDN \$ 000 (2011)

Strategic Outcome	Program	Actual Spending 2011–12	Alignment to Government of Canada Outcomes
1. Resources are delivered to meet Government Defence Expectation		4,334,325	
2. National Defence is Ready to meet Government Defence Expectations		10,169,909	
3. Defence operations improve Peace, Stability and Security wherever deployed	3.1 Situational Awareness ¹	599,459	A safe and secure world through international engagement
	3.2 Canadian Peace, Stability and Security	336,917	A safe and secure Canada

	3.3 Continental Peace, Stability and Security	202,580	A strong and mutually beneficial North American partnership
	3.4 International Peace, Stability and Security ²	1,980,673	A safe and secure world through international engagement
Sub-Total		3,119,629	
	4. Care and Support to the Canadian Armed Forces and Contribution to Canadian Society	1,516,338	
	5. Internal Services	1,078,558	
Total		20,218,759	

Source DND (2013)

APPENDIX 3.2

United Kingdom (U.K.) Experience in Other Parts of the Public Sector and the Private Sector

Other parts of the U.K. public sector have addressed the issue of measuring their outputs. Examples include health, education, public order and safety, transport, and social protection. The problems of measuring U.K. public sector outputs were reviewed by Atkinson (2005). This Review started by recognising that government output is generally non-marketed output and it is the absence of market transactions which underlie many of the problems of measuring public sector outputs. The traditional approach used in National Accounts' statistics is the output equals input convention (Atkinson 2005). The Review recognised that in the case of defence it is hard to identify the exact nature of the output (Atkinson 2005, 12). Some principles were suggested: Can we borrow from private sector experience (where the focus is on value-added)? Also, government output should be adjusted for quality changes (which is a problem for defence).

The Atkinson Review reported on experience of output measurement in public sectors such as health, education, public order and safety, and social protection. In health, it reported on the use of an aggregate output index constructed from separate series such as total numbers of in-patient and day cases. It recognised quality issues where health care embraces saving lives and extending the life span and preventing illness. It reported on the

possibilities of using quality measures of health care based on Quality Adjusted Life Years (QALYS).

Education output was measured by such indicators as examination results and the numbers of full-time school pupils (but numbers fail to reflect attendance). Public order and safety embraced police, fire, law courts, and prisons. Outputs were measured by such indicators as number of nights spent in prison, fires fought, and the number of crime-related incidents. Social protection includes the residential care of children and adults and output is measured by the numbers in residential care (Atkinson 2005). Experiences of measuring outputs in these parts of the U.K. public sector provide some guidance for measuring defence outputs.

Measuring health outputs involving saving lives and preventing illness have parallels in defence (as mentioned earlier, Chapter 9 of this book is another illustration). The development of QALYS for health might be extended to defence in the form of Protection Adjusted Life Years (PALYS). Since the Atkinson Review, the Office for National Statistics has continued to develop and improve output measures for various parts of the U.K. public sector. For example, education output measures are now adjusted for attendance and for quality changes (e.g. annual changes in examination points' scores: ONS 2010). Often the output measures, however, are aggregate indices with no valuation of outputs.

Experience of measuring output in the U.K. transport sector has addressed a key issue raised in defence: namely, the value of life and the value of lives saved by transport improvements. The value of life is based on a person's willingness to pay (e.g. for good health care and for road safety improvements). On this basis, the U.K. Department of Transport valued a life at £1.57 million and a non-fatal serious injury at £176,215 per person (2009/10 prices).

Experience in the U.K. private sector might provide guidance on the possible valuations to be placed on defence output. In the private sector, individuals and households allocate resources to protection and safety. Examples include insurance policies for protecting property; household

security measures (e.g. cameras, fencing, alarms, and dogs); car insurance and purchase of safer cars; location of homes in ‘safe’ areas; and the purchase of private medical and life insurance. In addition, there are public expenditures on protection, including police, fire and rescue services, prisons, as well as health care. Expenditures on these ‘comparator sectors’ provide an indication of society’s willingness to pay for various measures of protection.

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ⁱ This chapter is based on a report prepared by Keith Hartley for the Defence Research and Development Canada under contract number DND-10/23136. © Her Majesty the Queen in Right of Canada, as represented by the Minister of National Defence 2011. Parts have been updated to 2014.

ⁱⁱ See also Williamson (2000) for more nuanced discussion.

ⁱⁱⁱ For example, a nation's international peace-keeping contributions might provide considerable satisfaction to the country's Prime Minister, senior ministers, and civil servants able to attend international meetings at the UN and to participate in regional meetings. The principal-agent and public choice analysis raises the general question of who gains and who pays for these defence policies (e.g. international peace-keeping, national procurement of defence equipment including offsets)? Ultimately, taxpayers pay and receive some defence benefits whilst agents consume some benefits not explicitly supported by the majority of voters and taxpayers.

^{iv} For example, compare today's space satellite communications systems with the military communications facilities in 1914 (e.g. observation balloons).

^v Skills and productivity differ between regular forces, conscript, and reserve forces. Other complementary or substitutable labour inputs include civilian labour, contractors, national guard and reserves, and even police forces (e.g. police forces substituted for British Army troops in policing Northern Ireland: Ridge and Smith 1991).

^{vi} Note: Chapter 14 offers an interesting application of a new “real options” cost-benefit analysis of R&D investments.

^{vii} The varied results in this field reflect different economic and econometric models, combinations of variables, time-periods, cross-section and time-series studies; a heterogeneous set of countries; and the use of data of varying degrees of reliability and scope of coverage.

^{viii} With output budgets, a distinction needs to be made between the budget available to the Defence Ministry and the budget released to Parliament and the public. The published version of the budget does not reveal all the information available to the Defence Ministry and the basis for the choices which are reflected in the published version (Davies et al 2011, Chapter 17).

^{ix} As an example, note that on Table 3.3 Capital departmental expenditures limit (DEL) is part of overall resource DEL and reflects investments spending (cash) which appears in MoD’s balance sheet to be consumed over a number of years. The resource DEL includes depreciation and cost of capital changes.

^x Formerly known as Program Activity Architecture.

^{xi} Norman Augustine famously forecasted that with continued rising unit costs, by 2054, the entire U.S. defence budget will purchase just one aircraft which would have to be shared between the Air Force and Navy (the Marines would have it for one day in leap years). He also forecasted that the U.K. and France would reach this position two years earlier (Augustine 1987, 143).

^{xii} See Chapter 9 in this book for a novel application of the Statistical Value of Life.

^{xiii} It was not expected that both deployments would involve warfighting or that they would be maintained for longer than six months. One might be a short warfighting deployment; the other an enduring non-warfighting operation (SDR 1998, 23).

^{xiv} Small scale is defined as the U.K.’s deployment to Macedonia in 2001; medium-scale is Afghanistan (2001); and large-scale was operation TELIC (Iraq).

^{xv} An announcement that the optimum ratio for prolonged commitments was 3–4 ships and 5 Army and RAF crews/units for each one deployed (Cmnd . 6269 2004).

^{xvi} This would be about two-thirds of the force deployed to Iraq in 2003.

^{xvii} For example, its 2011 Report focused on success in Afghanistan reflected in the costs of operations; the costs of its force elements (e.g. a ship at an annual cost of £28 million; a fixed wing combat aircraft at £6.5 million per year); and the direct costs of Service personnel (£49000 per Service personnel per year: HCP 992 2011).

^{xviii} Interestingly, MoD's Performance Report included a section on Defence exports where one aim is to support British industry and jobs (HCP 992 2011). Defence exports are not an obvious output indicator for the MoD.

^{xix} There is a NATO (NATO 2010) commitment to spend at least 2% of GDP on defence; an aim of achieving savings from contract renegotiations with the defence industry; a goal to retain a surface fleet of 19 warships; a commitment to reduce the force of main battle tanks by 40%; and, lastly, a commitment to scrap the Nimrod MRA4 fleet (at a savings of some £200 million per aircraft: HCP 992 2011).

^{xx} The decision to replace the Collins' class submarines was confirmed but the life of the Collins' class was extended by seven years.

^{xxi} Compares to **Lines of Development** in U.K. and **DOTMILPF** (Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities) in the U.S.

^{xxii} None of the nations reviewed in this chapter addressed the challenges of measuring and valuing overall defence output. The nearest to an intermediate output measure consisted of the identification of various defence capabilities, but these were not always comprehensive. For example, the U.K. did not identify all its capabilities, including defence of the U.K. homeland, and the nuclear deterrent and no valuations were provided for the assorted capabilities. Nonetheless, the focus on defence capabilities is an improvement over the traditional focus on input measures such as numbers of personnel and equipment. The next challenge may be to assign weights to the mix of capabilities and aggregate them into an index that represents an overall measure of defence output.

^{xxiii} Nor should it be assumed that there exists a single 'best' indicator: performance indicators can often give unexpected and perverse results (e.g. the operation was a success but the patient died).

^{xxiv} For example, was the Iraq conflict a worthwhile investment for the U.S.?

^{xxv} Governments could use representative samples of voters to form focus groups which would offer their views on the size of alternative defence budgets and force structures. These focus groups could receive advice from officials and military personnel. Focus groups are not an ideal solution (e.g. free-rider problems remain; groups have to be selected; and they will have their internal momentum and dynamics), but would provide politicians with an additional mechanism for identifying voter preferences on defence spending and policy.