Issues in Measuring Defence Output: A review.

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Introduction

- Military expenditures are an input to produce some output. But in most national accounts calculations of GDP it tends to be assumed that, like many government expenditures, output equals inputs, no productivity growth.
- Usual account is that the defence budget finances forces, which provide military capability, which ensure security through defence or deterrence. Security is not an output that is easily defined or measured.
- Military expenditure also provides rents, influence and profits to the military industrial complex and has economic consequences. Again the question is what is produced or is it just waste?
- There is a tradition, not confined to any particular school of economics, which argues that military expenditures should not be included in GDP. Gelosi and Reilly (2024).

What is defence spending?

- What the UK reports to NATO on NATO definitions. Pensions? Gendarmes?
- What the UK reports in the National Accounts using the classifications of the functions of government, COFOG, definition developed by the OECD. Military health and education services are classified under health and education.
- What the UK reports in the Defence Budget using RAB definitions since 2001
  - current department expenditure limit (DEL)
  - capital DEL and
  - annual managed expenditue (mostly provisions, -£14bn in 2022-3, reflecting change to the Treasury discount rate).
- Capital Consumption/Depreciation complicates it. Balance sheet total assets of £200bn.
- There is a net cash requirement figure which is somewhat comparable with pre 2001 numbers.

Why do you want to measure defence output?

Definition of military expenditure/output depends on purpose:

- budgetary control
- how to judge the military balance, in terms of forces or capabilities? IISS (2024)
- how to judge burden sharing between allies? Kim and Sandler (2024) and RAND (2024)
- how to improve productivity to get the biggest bang for a buck? Davies et al. (2011) and Smith (2022). Defence productivity not like other sorts of productivity.
- how to measure output in the national accounts?

Each implies different measure.

Orthodox theory

- For country $i = 1, 2, ..., I$ in year t, National welfare W_{it}, is a function of consumption C_{it} and the security of country, S_{it} :

$$W_{it} = W_i(C_{it}, S_{it}) \tag{1}$$

  subject to a budget constraint
- Defence is commonly given as the classic example of a public good that is non-excludable and non-rival.
- The optimal provision of a public good occurs when
  - the sum of the marginal benefits over consumers equals the marginal cost of production or
  - where the marginal security benefit equals the opportunity cost, the other goods and services foregone.
- Does not help with measuring output.

Security

- Security is a function of the military capability of country i K_{it} and other countries K_{kt}, $k \neq i$,

$$S_{it} = S_i(K_{1t}, K_{2t}, , , , K_{nt}) \tag{2}$$

- A positive function for allies, negative for potential adversaries. Military capability depends on readiness, training and other intangibles. Often inappropriately approximated by spending.
- This is a hypothetical peacetime calculation which involves constructing a counterfactual: what would happen if you and the others changed their spending?
- The aggregation among allies or adversaries in (2) may depend on the minimum K : the weakest link in the chain; or the maximum K : the best shot; or other weightings.
- The big guys do not always win if their opponents fight them in ways that preponderance or technological advantage cannot be employed effectively.

Complications

- Additivity: you cannot add aircraft and pilots, the capability is the number of aircraft with pilots. The Defence Secretary, Ben Wallace, commented in November 2022 that "I have more F35s than I have pilots at the moment. Part of that is a Catch-22. You do not have enough instructors to train the pilots, so you do not have enough pilots to grow the instructors."
- There are further dynamic feedbacks since the right hand side elements of (2) are also linked
  - through arms races between adversaries:, increasing your military spending may not increase security if it prompts a larger response by the enemy
  - through free riding and burden sharing between allies: increasing your military spending may not increase security if it prompts allies to cut theirs.
- The security function is always context dependent and non-military responses to threats may be more effective than military ones.

Capability

- Capability depends on military investment, Q_{it}, in physical and human capital and depreciated past capability.

$$K_{it} = Q_{it} + (1 - \delta)K_{i,t-1} \tag{3}$$

  Output should depend on capability K but it is Q expenditure on personell and equipment that goes into GDP.
- Measurement of military capital is difficult, much of it is very old and its capability will depend on quality of maintenance.
- MOD says "we recognise that Military Capability is about more than just equipment, it is the combination and integration of equipment alongside our infrastructure, personnel, information, data, concepts, and training."

Investment

- Total investment, is the sum of investment in $j = 1, 2, ..., J$ types of forces, including enablers each with number $n_{ij,t}$ and quality $q_{ij,t}$.

$$Q_{it} = \sum_{j=1}^{j} Q_{ij} \left(n_{ij,t} q_{ij,t} \right) \tag{4}$$

- Cost effectiveness of particular procurements is judged through "combined operational effectiveness and investment appraisal" COEIA. Looks at equations (2), (3) (4). There may be externalities or spin-offs influencing output and war destroys output and capital.
- Capability will depend on stocks of munitions: missiles, shells, etc. There are incentives not to invest in an adquate inventory of munitions: spending on new equipment is much more visible; and in the UK, charges for capital consumption and depreciation make holding inventories costly.

Expenditure, deflator and budget constraint

- Current price military expenditure is the total cost of those forces

$$M_{it} = \sum_{j=1}^{j} n_{ij,t} p_{q,ij,t} q_{ij,t} \tag{5}$$

with price for a particular quality. $p_{q,ij,t}$. This is linear in $n_{ij,t}$, which does not allow for economies of scale or learning curves, which may be important in practice.

- The military price index, deflator, is $p_{mi,t}$

$$p_{m,it} = \frac{M_{it}}{Q_{it}} = \frac{\sum_{j=1}^{j} n_{ij,t} p_{q,ij,t} q_{ij,t}}{\sum_{j=1}^{j} Q_{ij} \left(n_{ij,t} q_{ij,t} \right)} \tag{6}$$

- Available national output can be spent on current price military expenditure $M_{it} = p_{mi,t} Q_{it}$ or consumption, with price $p_{c,it}$ so the expenditure side identify representing the budget constraint is

$$Y_{it} = p_{mi,t} Q_{it} + p_{c,it} C_{it}, \tag{7}$$

Defence

- Real defence performance measures include elements like success in operations, maintaining readiness, and stopping equipment being delivered late, over budget and not meeting technical requirements.
- Danger that measures of output in the national accounts may give perverse incentives.
- There is a problem of comparability because the nature of the activities, capabilities and objectives of defence change over time, as threats, technology and strategy evolve.
- When these activities or capabilities are discontinued to reorient to the new context, measured output will have fallen while the military are fully occupied doing different activities.

The changing nature of army objectives

CoGS, General Sir Patrick Sanders told HCDC "I have served in, if you like, four Armies:

- one that was optimised for the cold war;
- one that was optimised for interventions, starting with humanitarian interventions in Sierra Leone and the Balkans, and then expanded into interventions in the Middle East;
- one that reset itself for counter-insurgency or stabilisation operations in Iraq and Afghanistan and, tactically, became extremely proficient and well prepared for it; and
- now an Army that is optimising for war and for warfighting."

He also served during the Troubles in Northern Ireland. Measuring the capabilities to meet such changing objectives is challenging, let alone measuring the extent to which the objectives were met.

UK National Accounts

- The Atkinson Report of 2005 encouraged the ONS to adopt measures of the volume of output for some government services. Volume being measured in elements of health and education by the number of activities performed.
- This can cause problems. When Universal credit was introduced it replaced a set of other benefits, seeming to be a reduction in activity. During the pandemic closing schools meant that UK output fell more than other countries. Preventative activities whose best outcome is nothing happens are hard to measure.
- In 2023 the Chancellor of the Exchequer commissioned ONS to do a Public Services Productivity Review.
- I contributed a review of the issues involved in measuring defence output in ESCoE Discussion Paper 2024-06, April 2024.
- The main report was published in March 2025: The national statisticians independent review of the measurement of public services productivity, UK Statistics Authority, (UKSA).

UKSA Approach

- UKSA starts from the basic formula

$$Output = \alpha ActiveDeployment + \beta Deterrence$$

- It recognises the difficulties of measuring each and choosing a weighting, and notes that they are not independent, active deployment might increase deterrence and increased deterrence reduce the need for active deployment. In addition both depend on the actions of allies and adversaries.

It describes the

- Demand for deterrence as the product of the probability of attack, the value of assets protected and the proportion of those assets that could be destroyed in such an attack.
- Increased adversary capability increases the probability of attack and the proportion of assets that would be destroyed.

Defence as insurance

- UKSA treat UK defence capability as akin to an insurance policy against risks such as attack.
- The probability of an attack could be based on military knowledge, national threat levels, or spending by potentially hostile state actors.
- Since the basis of the exercise was that output was not equal to input for the UK it would be inconsistent to assume it was for other countries which would be implied by using spend.
- UKSA suggest measuring defence capability by defence spending times readiness, demand for UK deterrence as given by the geopolitical risk index as measuring the economic cost of a deterred attack $\times$probability of an incident occurring. The ratio gives a measure of output: supply divided by demand: relative insurance.

Readiness and risk

- MOD may publish data on readiness, broadly aligned with NATO's recommendations, based on:
  - Availability: the number of platforms (e.g. tanks, frigates, drones etc) within a particular time frame.
  - Capability: what the platforms can do.
  - Sustainability: how long these activities can be sustained for.
- Readiness measures can be sensitive for security and political reasons.
- Their preferred demand measure was the geopolitical risk index (GPR). Caldara and Iacoviello (AER 2022). Problem that it is rather spikey.
- C_t : Defence Capability=Defence Spending x Readiness
- D_t : demand for deterrence based on the GPR.
- Output growth

$$\frac{O_t}{O_0} = \frac{C_t / D_t}{C_0 / D_0}$$

Concluding thoughts

- Defence review imminent. Threat increasing; allied guarantees more questionable: too dependent on US?
- Financing increased defence expenditure will be an issue. World War II the UK devoted half of output to defence, and Ukraine was said to be devoting about 40% in 2024.
- Theory does not provide a lot of help in defining a national accounts measure of the output of defence.

THANK YOU