An Overview of the *Defence and Peace Economics* Special Issue on Defence Inflation

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Abstract

This document provides a summary of the key issues discussed within the 2015 Special Issue on Defence Inflation in the Journal of Defence and Peace Economics. Five articles are covered within this summary, detailing the experiences and perspectives of the United States, the United Kingdom, Sweden, and Norway.

Résumé

Le présent document contient un résumé des questions clés abordées dans le numéro spécial de 2015 du Journal of Defence and Peace Economics sur l'inflation au sein de la Défense. Ce résumé porte sur cinq articles décrivant en détail l'expérience et le point de vue des États-Unis, du Royaume-Uni, de la Suède et de la Norvège.

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1 Introduction

This document provides a summary of the key issues raised by the authors of the articles in the 2015 Special Issue on Defence Inflation in the Journal of Defence and Peace Economics. In total, five articles are included, describing the experiences and perspectives of the United States, the United Kingdom, Sweden, and Norway. Further, two of the papers provide new estimates of defence inflation using historical data.

1.1 Definition of Defence Inflation

Inflation, in general, refers to the rising price level for goods and services in the economy. Most economists describe this phenomenon as one that is primarily monetary in nature; that is, it is largely driven by the central bank's expansionary monetary policy.

Defence inflation refers to the total increase in cost of defence goods and services over time. A portion of defence inflation is caused by the general inflation level in the economy while another, often larger, portion is caused by a variety of factors that are unique to the context of national defence.

Within the Special Issue, the authors adopt nuanced definitions of defence inflation, with some drawing distinctions between the inflationary component and the "cost escalation" which is not driven by economic inflation, and others referring to these collectively. To avoid ambiguity, within this summary we adopt the definition of *defence inflation* as the *total increase in cost of defence goods*, while *defence cost escalation* refers to the *portion of total defence inflation that is caused by defence-specific factors*.

1.2 Cost Escalation in the Context of Defence

The papers in the Special Issue devote considerable attention to the causes of defence cost escalation. In order to understand the authors' perspectives on this phenomenon, it is important to detail what differentiates the market for defence goods and services from others. This is described briefly in the next section, *The Market for Defence Goods*. The drivers of cost escalation are then summarized in the *Causes of Defence Cost Escalation* section.

2 The Market for Defence Goods

The primary difference between defence markets and most other markets for non-military goods is that they typically have a small number of suppliers and consumers for any given product; they are, in effect, bilateral monopolies or oligopolies. This market structure produces suboptimal outcomes in terms of prices offered and quantities supplied as compared

to the case of perfect competition [1, 2, 3].

Restrictions to firm entry and international trade also presents difficulties in producing efficient market outcomes in the defence sector. Governments favour domestic production of defence systems over procurement from international suppliers who may be able to offer the same products at lower cost [3]. High research and development costs make it difficult for firms to enter the market, reducing the potential for competition [1].

Government behaviour also imposes inefficiencies on the market. Public choice theory predicts that the differing incentives between political parties and government bureaucracies produce market outcomes that are below the optimum. Further, contracting practices between government and industry partners, such as fixed-cost or cost-plus contracts, tend to provide little incentive for firms to become more efficient [1, 4].

3 Causes of Defence Cost Escalation

3.1 Quality Improvements and Technology

As described by Hartley [1], the rising real unit costs between generations of equipment usually reflects new technology and changes in project characteristics. For instance, modern combat aircraft outclass those from older generations in terms of speed, maximum altitude, weapons payload and effective range. Clearly, a certain portion of cost escalation is due to absolute improvements in capabilities: Keating and Arena assert that the cost escalation that occurred during the shift from the F-15A to the F-22A combat aircraft was largely driven by "customer-driven factors, in particular vastly increased system complexity" [5]. Innovations in defence systems also become more expensive the closer they are to the technological frontier of the time [2].

3.2 Strategic Behaviour

The pursuit of high-end technology in defence systems is, in part, a consequence of strategic behaviour, as countries seek to develop a relative advantage in military capabilities. Asymmetric information exists between countries, and any given country is unable to know the full capabilities of their potential adversaries; it is also impossible for a given country to anticipate future threats with certainty. As a result, the incentive for a country to innovate progressively further along the technological frontier is likely to be significant, as the potential cost of being left with relatively ineffective defence platforms is high [2].

This discussion leads to the concept of military equipment as *tournament goods*. Essentially, this states that the value of military equipment is based on its capabilities *relative* to that of a potential adversary; the equipment itself does not have inherent value. Because superior military equipment increases the likelihood of winning a conflict, countries are incentivized to keep up a reasonable relative capability over time. This is especially costly

if potential adversaries are also continually improving their own defence platforms, as each country attempts to obtain, or maintain, a relative advantage over the other [2, 3].

Since countries aim to maximize not the absolute level of capability for a given defence system but the *difference* between the capabilities of their systems versus those of their potential adversaries, evaluating the defence cost escalation argument in terms of *absolute* changes in defence system quality is insufficient. The strategic implications to defence system procurement can lead countries to continually increase spending in research and development or target the acquisition of defence systems of increasingly higher levels of technological complexity. The rate of cost increases could thus outpace that which is justified by economic inflation or absolute capability.

3.3 Changes in the Defence Market

As discussed previously, a market wherein suppliers hold substantial market power will tend to have higher prices and produce lower quantities than they would otherwise. For unit costs to be increasing in real terms, suppliers must be gaining market power over time.

One possibility for suppliers to gain market power is a reduction in the overall number of suppliers within a market either through exits, mergers or acquisitions. This phenomenon has occurred in a number of defence markets over the past few decades. Hove and Lillekvelland [2] point to a declining number of defence firms due to mergers and take-overs, such as Northrop Corporation buying the Grumman Aerospace Corporation in 1994, the merger of Lockheed and Martin Marietta in 1995, and Boeing's merger with McDonnell Douglas in 1997. A similar trend has occurred in the Canadian munitions industry: Canada's Munitions Supply Program (MSP) has reduced from six industry partners in 1978 to four at present [6].

Asymmetric information between the supplier and government can also result in increasing real prices. Suppliers can potentially exploit their superior information on production costs and timelines, particularly in the case of technologically advanced products, to obtain a greater price for their product [2]; if this information asymmetry increases over time, this could produce cost escalation.

4 Effects of Defence Inflation

Defence inflation places pressure upon defence budgets. If it is the case that defence budgets remain stable in real terms (i.e., with respect to economy-wide inflation), and the provision of defence increases in cost at a greater rate, some substitutions or compromises must occur. The following four courses of action may be adopted as a country nears its budgetary limit: [2]

1. Increase the budget in order to keep up with overall defence inflation;

2. Invest in equipment with lower cost escalation across generations;[1]

3. Reduce the number of units procured within each platform; or,

4. Reduce the total number of platforms and capabilities.

Each of these presents limitations: '1' may not be politically desirable; '2' may not make sense from the *tournament goods* perspective, as equipment with lower cost escalation would tend to be of lower technical quality and thus less effective in relative terms; '3' is limited in terms of minimum units needed for viability of a given platform (i.e., a country cannot effectively operate only one fighter aircraft), and '4' sacrifices a set of capabilities. Hove and Lillekvelland note that the most preferable option would naturally depend on country characteristics: large countries could reduce the number of units procured and maintained, while smaller countries would consider reducing the total number of platforms. As an example of the latter, Denmark disbanded its entire submarine capacity in order to allocate this portion of its defence budget to alternative uses [2].

5 Defence Inflation Rates Across Surveyed Countries

Keating and Arena present average annual defence inflation rates from 1974 to 2005, covering an array of US Air Force and US Navy aircraft in service over this 30-year period. The estimates are sorted according to aircraft type, with numbers ranging from 7.6 percent for fighter aircraft to 11.6 percent for patrol aircraft, compared to an average economic inflation rate of 4.3 percent per year over the same period [5].[2]

Surveying the experience of the UK over a 9-year period beginning in 2005, Hartley presents MoD estimates of defence inflation in the range of 1.5 percent to 4.2 percent. These figures are independent of the rate of economic inflation. Taken together, the rate of defence inflation surpassed economic inflation by an average of 1 percent per year. These numbers explicitly remove the effects of increases in cost and quantity, and reflect the average costs of *all* goods and services in the UK defence budget; as a result, they are significantly lower than the estimates presented by the other authors within the Special Issue, which are generally conditioned on the inflation of defence systems in procurement [1].

Nordlund reviews defence cost escalation estimates conducted in 2011 by FOI, the Swedish Defence Research Agency. These encompass military equipment such as automatic rifles

[1] Investing in equipment with lower cost escalation could mean, for instance, not pursuing the bleeding edge of technology in weapons systems procurement and instead opting for a mature product with more certain and stable costs.

[2] These estimates are sourced from an earlier research paper by Arena et al. [7].

and ammunition and defence platforms such as combat aircraft, corvettes, submarines, tanks and armoured personnel carriers. The time periods included in the analysis vary by weapons system, but generally span from the 1960s until 2010, with some data series beginning in the 40s and 50s. The estimates, which are *net of economic inflation*, differ substantially across weapons systems: tanks have the lowest cost escalation, with annual rates of 0.7 percent, while fighter jets, 'medium' helicopters and corvettes each come in approximately at 7 percent above inflation.

5.1 New Estimates

Hove and Lillekvelland employ standard ordinary least squares and principal component regression analysis to derive estimates of defence cost escalation. These are presented in Tables 1 and 2. The dataset employed in this analysis contains 280 observations of defence systems employed by a variety of countries. The results show annual defence cost escalation rates varying between 1 and 7 percent above the economy-wide inflation rate, with aircraft (both fighter and transport) systems at the top of the inflation spectrum and frigates, main battle tanks (MBTs), and small arms towards the bottom. When controlling for production quantity and quality characteristics, the "unexplained" portion of defence inflation - that is, that which is not explicitly accounted for in terms of quality or quantity - the results return between 1 and 4 percent yearly cost escalation, with roughly the same ranking across systems as in the uncontrolled regression [2].

Horowitz, Harmon and Levine produce estimates for defence inflation in the United States, drawing upon data from 22 separate aircraft programs that existed at some point over a 40 year span from 1973 to 2012. Their research attempts to control for system quality (by accounting for characteristics such as weight, maximum speed, and use of advanced materials) and quantity produced. The regression, which does not take economic inflation into account, returns annual defence inflation rates of approximately 5.9 or 6.5 percent depending on the metric adopted [8].

Table 1: *Hove and Lillekvelland—Estimates of Total Cost Escalation.*

Total Cost Escalation	
	OLS [a]
Platform	Rate [b]
Transport Aircraft	0.072
Fighter Aircraft	0.068
IFVs [c]	0.051
Artillery Vehicles	0.044
Submarines	0.044
FACs [d]	0.035
Helicopters	0.025
Frigates	0.024
MBTs [e]	0.021
Small Arms	0.012

Notes: **(a)** Results from an Ordinary Least Squares regression.
(b) Annual percentage rates **above** economy-wide inflation.
(c) Infantry fighting vehicles.
(d) Fast attack crafts.
(e) Main battle tanks.
Data consists of 280 observations, from a variety of countries, occurring between 1828 and 2012.

Table 2: *Hove and Lillekvelland—Estimates of Unexplained† Cost Escalation.*

Total Cost Escalation		
	OLS [a]	PCR [b]
Platform	——————— Rate [c] ———————	
Transport Aircraft	0.041	0.031
Fighter Aircraft	0.040	0.038
IFVs [d]	0.021	0.021
Submarines	0.022	0.017
FACs [e]	0.048	0.005
Helicopters	0.027	0.006
Frigates	0.002	0.008
MBTs [f]	-0.015	0.011

Notes: † Regression adjusts for quantity and quality characteristics.
(a) Results from an Ordinary Least Squares regression.
(b) Results from a Principle Component Regression.
(c) Annual percentage rates **above** economy-wide inflation.
(d) Infantry fighting vehicles.
(e) Fast attack crafts.
(f) Main battle tanks.
Data consists of 280 observations, from a variety of countries, between 1828 and 2012. Artillery vehicles and small arms were not included in this set of regressions.

6 Conclusion

This reference document provides an overview of the phenomenon of defence inflation as described by the authors of the Defence Inflation Special Issue within the Journal of Defence and Peace Economics. Among the hypotheses concerning the drivers of cost escalation proposed and explored by these authors, three relatively consistent elements emerged: first, quality improvements across and within generations of defence systems; second, strategic behaviour on the part of countries and the *tournament goods* concept as it applies to military equipment; and third, dynamic changes within the defence goods market leading to increased supplier power.

The authors also review estimates of defence inflation across a number of countries, and two papers provide new estimates. The estimates exhibit significant heterogeneity, depending on the type of defence cost included (i.e., labour costs versus high-end aircraft procurement) and which country is under study. The estimates vary between an average of 1 percent above inflation, in the case of the total UK defence budget [1], and an average of 11.6 percent in the case of US Air Force combat aircraft. Caution should be exercised in interpreting these results, as the studies employ differing approaches, datasets, controls, and estimation methods.

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