DAVIES ECONOMIC CONSULTANCY LTD

Managing Defence Acquisition Cost Growth

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CONTENTS

1 Introduction

1.1 Context

1.1.1 This paper has been produced for SCAF's annual conference and has reflects:

- Private Venture (PV) work undertaken by Polaris Consulting Limited and Davies Economic Consultancy.
- Work undertaken for a report for the European Union Institute for Security Studies (EUISS) on the impact of defence equipment cost inflation in Europe.

1.1.2 The paper has drawn on previous studies into the subject, coupled with findings from work recently undertaken by Davies Economic Consultancy and Polaris Consulting.

1.2 Introduction & Background

1.2.1 With defence budgets under strain, the growth of the cost of defence equipment is becoming increasingly important. It affects budgetary allocations and resources, causes more intense political discussion and eventually can have a detrimental effect on defence capabilities.

1.2.2 Previous studies into the increasing cost of defence capability have identified a number of separate drivers:

- the differential between defence inflation and CPI – "defence inflation";
- inter-generational unit cost escalation;
- the deleterious financial impact of buying smaller numbers of platforms within a given class or type;
- the reduction of the competitive market for many defence platforms;
- and the way in which budgetary difficulties are tackled by delaying projects.

1.2.3 In many cases these drivers reinforce one another; for example, escalating unit cost means smaller numbers of platforms, which in turn can drive industry to consolidate and reduce the number of companies able to compete for business. Nonetheless, they may be considered to be individual factors responsible for increasing defence costs, the resolution of which each of which may require different solutions.

1.2.4 Various countries have developed approaches to control aspects of cost growth, e.g. the US developed the discipline of Cost as an Independent Variable (CAIV) to control the real terms cost growth of the Joint Strike Fighter (JSF) while the UK has gone through a number of attempts to reform its defence procurement to tackle cost over-runs and delays, but to little avail.

1.3 Scope of this report

1.3.1 This paper is structured as follows:

- Section 2 presents a summary of the findings of previous research and analyses their findings.
- Section 3 describes some new research into naval ships.
- Section 4 discusses approaches taken to tacking the issue of equipment cost growth.
- Section 5 describes potential responses to the issue and presents our conclusions.

1.3.2 The report is supported by a series of Annexes reporting more detailed findings.

2 Summary of Intergenerational Cost Escalation Literature

2.1 Review of Literature

2.1.1 The concept of cost escalation as a phenomenon within defence was first recognized by Norman Augustine in his "Final Law of Economic Disarmament", which suggested that by 2054 only a single aircraft will be economically viable for the United States' military due to its immense cost, as an unlikely but informative jumping off point for considering the potential effects of Intergenerational Cost Escalation on military budgets.

2.1.2 In 1959 a RAND study (by Marshall and Meckling) found that US defence projects were often optimistically costed initially, while a similar piece of work done in 1980 (by Spinney) contended that the increasing technological demands of military equipment and the defence-industrial complex in the United States was driving increased costs.

2.1.3 In the UK, both Pugh (Pugh, 1993) and Kirkpatrick (Kirkpatrick, 1995) separately and together (Kirkpatrick and Pugh, 1983) found substantial real terms Intergenerational Cost Escalation stemming from the utility of defence equipment, which is derived from its effect relative to an adversaries own equipment, making it necessary to ensure that equipment is as good, if not better, technologically than a potential opponent. Defence acquisition is essentially a zero sum activity in which both side must improve their equipment constantly to gain or maintain superiority over the other. Kirkpatrick and Pugh (1983) came up with estimates for intergenerational cost growth for combat aircraft of 8.3%. Kirkpatrick later (1995) revised this to 11.5% pa in real terms- ie over and above general inflation. Pugh (1986) produced estimates of around 5% for aircraft carriers, 11% for frigates, 9% for destroyers and for submarines and 8% for helicopters and 9% for fighter aircraft. Pugh (2007) estimated cost growth for naval platforms across many different countries of 3% per ton - using tonnage as a proxy for capability.

2.1.4 In contrast to the relatively high numbers produced by Kirkpatrick and Pugh, Chalmers (2009) focused on the more recent period comparing the unit cost of the Typhoon with the Tornado F3, the Astute with the Trafalgar class submarine and the Type 45 with the Type 42 destroyer; he obtained annual real terms growth of 3.4%, 2.2% and 2.8% respectively.

2.1.5 A RAND study by Arena et al (2006) looking at US naval ships found nominal rates of annual cost escalation of between 7% and 11%. About half of this could be attributed to economy wide factors affecting the price of labour and materials and about half reflected customer driven factors- equipment complexity, standards and requirements. Hence, for surface combatants between 1990 and 2004, annual real terms cost growth due to customer driven factors was 3.4% - similar to Chalmers estimate for the Type 45 v Type 42 destroyer. Over the longer term from 1950 to 2000 Arena et al obtained estimates of real terms cost growth (over the US GDP deflator) of 6.3% for amphibious ships, 6.2% for surface combatants, 5.3% for attack submarines and 2.9% for carriers.

2.1.6 For Kirkpatrick, Pugh, Davies et al, and Hove and Lillekvelland, the key to Intergenerational Cost Escalation with defence equipment lies with the idea that they represent tournament goods which has value only in relation to its relative performance compared to that of others. Both studies measure how much, on average, Intergenerational Cost Escalation increases above both the consumer price index (CPI) and defence specific inflation (DSI).

2.1.7 Annex C provides charts illustrating cost escalation and the reduction in the number of platforms operated as a consequence.

2.1.8 Annex A describes how different approaches have been adopted to measuring defence equipment cost escalation, and their results.

2.1.9 This work enables the following definitions to be made:

- Defence Inflation or Defence Specific Inflation (DSI) - the rate of increase in the price of a bundle of goods and services purchased by Ministries of Defence, measured in the form of an index - eg see UKDS.
- Differential Defence Inflation- the difference between the rate of increase in the price of a bundle of goods and services purchased by Ministries of Defence and the rate of increase in economy wide inflation as measured either by the GDP deflator or Consumer Price Index (CPI). Differential Defence Inflation measures the real terms rate of increase in the price of defence goods and services.
- Intergenerational Defence Equipment Unit Cost Growth- this measures the rate of increase in the unit cost of defence equipment between one generation of equipment and the next expressed in annual percentage terms and usually in real terms as compared to the rate of increase in economy wide inflation.
- Defence Equipment Unit Cost Growth- the rate of increase in the cost of individual items of defence equipment. This may be measured in nominal or real terms. It includes both Intergenerational Defence Equipment Unit Cost Growth (see below) and shorter term consequences of growth in cost due to project cost overruns and differential defence inflation.

2.2 Analysis

2.2.1 All the studies of Intergenerational Cost Growth emphasise the importance of the "Tournament" nature of defence goods. Both Davies et al and Hove and Lillekvelland find that for most categories of defence equipment regression analysis shows that cost growth is entirely explained by increases in performance parameters. For some categories, eg air platforms there is a residual element not so readily identifiable.

2.2.2 By contrast, civilian goods (except for rare items such as Formula One racing cars) do not exhibit such rates of cost growth. The price of family cars, for example, has increased slightly more than average consumer prices but lower than the rate of growth in earnings, despite dramatic improvements in characteristics-eg performance, comfort, economy etc. Competition between producers and affordability considerations on the part of consumers have moderated price growth.

2.2.3 Davies et al suggest that intergenerational cost escalation for UK defence platforms has been lower than estimated by Pugh and Kirkpatrick but similar to estimates from Arena and Chalmers. They conclude that changes in the characteristics of platforms- size, speed, engine power etc, can explain virtually all the observed intergenerational cost growth. This does not mean that intergenerational cost escalation is /has been discretionary as they suggest the choice of characteristics has been driven by the imperative to match rivals.

2.2.4 Hove and Lillekvelland discuss the role of technology upon equipment costs. Where a nation is pushing beyond the highest current level of technology they will incur much greater costs due to the need for investment in the development of new technologies as well as in the equipment itself. Higher levels of technology can yield much more complex equipment which, in turn, could impact negatively upon that equipment's reliability. Whilst achieving what is known as the "winning margin", the slim difference between victory and defeat, can be important, it can also be counterproductive to push for the absolute best performance if it significantly increases cost and complexity.

2.2.5 In addition, the kind of suppliers who cater to the kind of performance and effectiveness sort by nations near or at the current technology threshold generally have a great deal of market power as their skills are very specialized and thus few such suppliers will likely exist. As such there is very limited competition within the market for defence equipment. This lack of suppliers and the

subsequent greater market power may result in decreasing incentives for efficient productivity, further driving up costs.

2.2.6 Hove and Lillekvelland draw attention to what both Pugh and Kirkpatrick first highlighted as what is now known in the literature as the "vicious circle of cost escalation" or "circle of doom". This is the phenomenon whereby intergenerational cost escalation leads to higher unit costs which means fewer platforms can be afforded than before which in turn leads to a loss of economies of scale (including the sharing of overhead costs and R&D costs between fewer units of production) and loss of economies of learning which leads to even greater increase in unit costs.

2.2.7 Because of this both the supplier and the customer have a great deal of market power as both are extremely limited, thus costs will fall somewhere between those produced by a monopoly and a monopsony (single purchaser). However because demand comes near exclusively from states this also means that procurement of defence goods becomes a very political issue. As such marginal utility and costs may not be heeded as much as they could otherwise be because projects may, for instance, be exaggerated or unnecessarily spread across multiple electoral boundaries to fulfil political rather than military requirements. Similarly, buyers are not perfectly rational actors and do not possess perfectly accurate information, thus, the study suggests, because the costs of failing to gain or keep advantage over an adversary are so great they are likely to favour complexity as an indicator of performance, even if this incurs much greater costs. Where defence equipment is bought for reasons other than quality or need, eg because nations "bandwagon" and buy equipment because either everyone has it or because allies possess it and the ability to network equipment with them is valuable. Finally the study describes how nations might decide what level of spending is appropriate on the military, a complex topic that depends on many political, societal and economic factors. What they conclude is that, regardless of spend, any nation reaching the upper limits of its ability to spend on defence equipment must decide whether to either increase that spending and face the political cost of doing so or else cut its military back in some areas in favour of better equipment in others. They outline ICE's potential to significantly impact long term defence equipment costs and suggest a matrix developed in the Kvalvig and Johansen (2008) study as a good guideline for long term planning in regards to ICE. However they do otherwise recommend that ICE be determined on "reasoning rather on only relying on a matrix of values", utilizing the matrix only as a rule of thumb.

2.2.8 One response to the problem of unit cost escalation has been the move towards international collaboration, particularly in the production of military aircraft. Examples include the Anglo-French development of the Jaguar, the 4 party (UK, Germany, Spain and Italy) development of the Tornado and Typhoon, the 11 nation collaboration in the development of the A400M and the development of the JSF. The earlier multinational collaborations were disappointing as the savings from increased economies of scale were at least partly offset by additional costs associated with compromising on specifications, extra time delays and "Juste Retour" arrangements for work sharing.

2.2.9 In addition to the loss of economies of scale and learning, unit costs have been driven up further by the pattern of Defence industrial consolidation and reduced completion that has followed the end of the Cold War. In the UK this has led to 40% of defence equipment being sourced from one company – BAE Systems- despite a professed policy of seeking to place orders competitively. EADSB has secured a similar dominance amongst continental European Nations.

2.2.10 In response to historic evidence of Intergenerational Cost Growth, the US led consortium developing the JSF adopted a new initiative in the late 10990s called Cost As (an) Independent Variable – CAIV. This was intended to effectively curb cost growth due to the military customer(s) adding additional specification requirements as the programme progresses to meet theoretical threats from rival nations' competing new platforms. The concept of CAIV was that any such extra specifications would be have to be traded off against cost, which would be held fixed as separate parameter. CAIV was quietly abandoned as the champions of cost control were too weak to stop their military colleagues insisting on specification changes in the interest of military effectiveness.

2.2.11 Cost Growth has typically been accompanied by delays in delivery. This is partly a manifestation of cost growth in an alternative guise as suppliers have been just as unable to meet demanding and unrealistic time schedules as demanding and unrealistic cost schedules. In addition budgetary constraints have often necessitated further delays while supplementary funds were sought or as a device to manage the cost growth through slipping interim payments into the next financial year.

2.2.12 To conclude, there is limited and tentative evidence of a possible recent reduction in Intergenerational Cost Growth (Chalmers and FFI study) perhaps reflecting reduced pressure on nations to compete to develop ever more capable defence platforms with the end of the Cold War. The very long latency periods with major defence projects makes it difficult to be definitive about this. There have been very few new programmes begun after the end of the Cold War which have been completed.

3 Impact of Cost Growth: A Case Study

3.1 Introduction

3.1.1 The literature points towards escalating defence equipment costs as a reality which is driven by the higher rate of defence inflation to CPI, and of intergenerational cost growth. These factors in turn drive a more restricted industrial base, reducing competition, and can lead to delays in projects being introduced to achieve affordability. This Section reports on a case study conducted to look at the impact of escalating defence cost, based around the UK Royal Navy (RN). This is explored before widening the analysis to how other nations have managed, or tried to manage, its impact in recent years.

3.2 Case Study: the Royal Navy

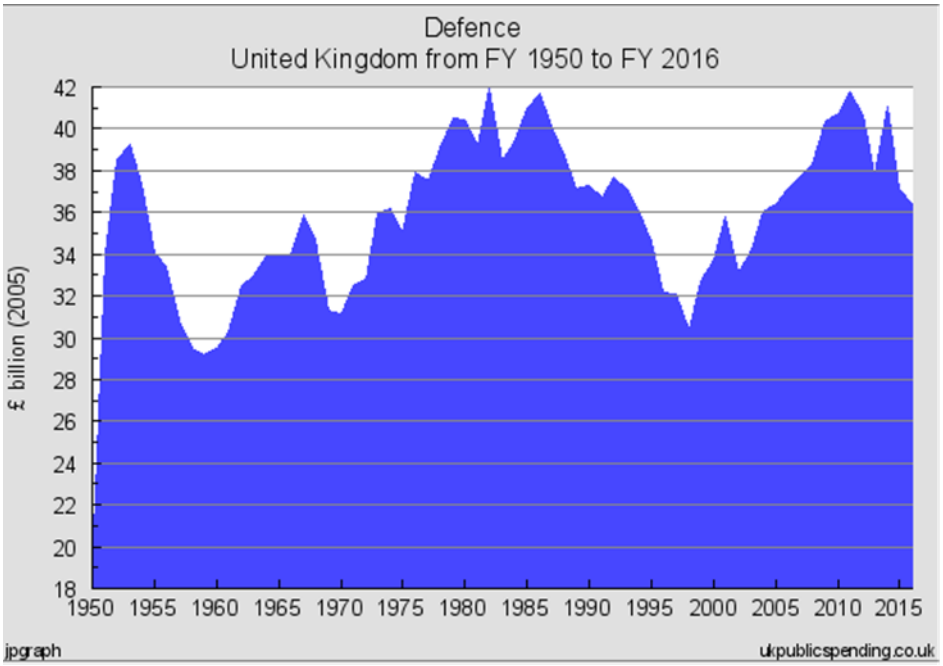
3.2.1 A review for this study of major Royal Navy platforms over the past 55 years has demonstrated the outcome of cost growth. Out of the 19 major platform types analysed, 11 entered service later than planned, 9 out of 18 were over budget, and 6 out of 19 had fewer units acquired than originally planned.[1] What is more ominous still, however, is the tendency of more recent platforms to exhibit higher budgetary overruns, delays or cuts in numbers of platforms. This is most noticeable in platforms recently or currently entering service, such as the (new) Queen Elizabeth class carriers, Type 45 destroyers and Astute submarines. Of course it may be that more recent estimates are more readily available, and caution must be applied to all the data which has been gathered, but the raw data of higher costs and delays is supported by more qualitative evidence.

3.2.2 See Annex B for a list of major RN ships in the time period in question; while Annex E highlights the delays and issues around those platforms; and Annex F shows which RN programmes experienced time delays into service, cost overruns and/or reduction in number of platforms.

3.2.3 This analysis of individual classes must be considered against the backdrop of repeated defence reviews which have reduced the size of the Royal Navy. The last SDSR reduced the number of escorts to 19, a much reduced number from the 50 available in the 1970s; the reduction to 40 of which led an outcry and reversal of the decision after the Falklands War.[2] Although the fall in the number of major platforms and nuclear submarines has been less sharp, there has been an inexorable fall in both the number of vessels since the 1950s. In practice, most - or all – Defence Reviews have actually been struggles to achieve a match between operational capability and fiscal reality, or to exploit the peace dividend at the end of the Cold War.[3] Even those claiming to be led by policy or strategy have really been about reconciling UK forces with diminishing finances.

[1] The actual cost against budget for the original Queen Elizabeth class carriers (CVA-01) cannot be calculated as they were never built.
[2] The Nott Review of 1981, see A Brief Guide to Previous British Defence Reviews, ref SN/IA/5714, 19 October 2010, House of Commons Library, p.7.
[3] A Brief Guide to Previous British Defence Reviews; and Securing Britain in an Age of Uncertainty: the Strategic Defence and Security Review 2010, HM Government.

Figure 2 UK Defence Spending Adjusted to 2005 Prices[4]



3.2.4 Yet, for all the repeated crises facing UK Defence, its budget of the UK has remained remarkably constant in real terms over the past sixty years. Although the percentage of the UK's GDP spent on defence has fallen from close to 10% in the 1950s to 2% in the same period, expenditure in real terms has stayed the same (see Figure 2).[5] The proportion spent on the RN may have changed over this time, though changes to MOD's accounting arrangements make it difficult to assess this. Yet the fleet of 2015 is substantially smaller than that of the 1960s, let alone that of the 1950s.

[4] The source of Figure 2 is http://www.ukpublicspending.co.uk

[5] Planning in the 1950s was predicated on the defence budget rising to approximately 10% of GDP in response to the Cold War and the Korean War, A Brief Guide to Previous British Defence Reviews, p.3. The Government committed, following the 2015 election, to maintaining defence spending at 2% of GDP in line with the NATO target.

3.2.5 Tonnage and numbers of major units cannot be equated with capability delivered. The RN of today is vastly or capable than that of 1960, and could outfight its old self with ease, although the restricted number of platforms will impose real limitations on its ability to deliver concurrent operations. The money spent today is delivering far more capability, so - in some respects - worrying about decreased tonnage or number of ships is misleading. In addition there is a notable tendency for like for like platforms to increase in tonnage with each generation, such that the number of ships and submarines has fallen more rapidly than the gross tonnage.[6]

3.2.6 Nevertheless, the UK's *relative* ability to deliver effect on the global stage has fallen. While its GDP has risen, the proportion of that GDP to total world GDP has fallen. In other words, other nations have gained economic power more quickly, leading to the UK having less relative capability.[7] Compared to the 1950s, when the only other significant maritime power was the (by then much larger) US Navy, in the contemporary world many nations have significant surface, airborne and submarine forces capable of projecting power locally and globally.

[6] Intergenerational Equipment Cost Escalation, DASA-DESA Economic Working Paper No.1, Nov 2011.
[7] See Kennedy, P., The Rise and Fall of the Great Powers. Kennedy's thesis is that the ability to project military force is underpinned by economic power, at least in the long run, and that differential economic growth rates mean that the relative power of one nation, in comparison to its adversaries and allies, inevitably changes over time.

3.2.7 The Queen Elizabeth Class carriers, for example, cost more than the original estimates, and are now due into service in 2018, compared with an original estimate of 2012 in the SDR of 1998, when they were first conceived.[8] Although the two originally planned carriers will be built, questions remain over the readiness of the second carrier, and of the size of air group which will be available.[9] Certainly, compared to the original estimates of 36 Lightning II aircraft each, the current view of a small number (12) embarked with reliance on surging to a joint force is considerably less impressive. Similarly, only 6 Type 45 destroyers were eventually built as against the 12 originally planned, and the Astute class has suffered from numerous overruns and delays.[10]

3.2.8 All nations face the challenge of increasing defence costs. The key problem for European countries is that increasing defence costs can render capabilities problematic or even non-existent. Examples may be identified in the area of the Royal Navy where costs have reduced the number and capability of platforms so far as to make their ability to deliver their intended capability *intermittent* or compromised. Take the example of carrier strike; Augustine's Law is often seen as an unrealistic outcome, and yet this is precisely what has happened since 1998 due to UK policy and acquisition.[11] UK carrier strike was seen as the centre piece of the maritime component of SDR98, and the lynchpin of the ability of the UK to deliver expeditionary warfare. Yet, in practice, the capability has all but vanished in the period 2012 to 2020, as it is currently unaffordable. Further, when it returns around 2020, what will be available will face real constraints: with maybe only one carrier operational at a time, equipped with a standing air group a third that planned in the early 2000s, and very small numbers of Type 45 destroyers available to protect the carriers. The capability as originally envisaged will be reduced to the point of marginality. It may not be available at all times, and may not be as protected as originally envisaged. This is not to suggest that the capability provided will be without value, capable of surge, or able to deliver useful missions, but it will be severely compromised compared to the original proposition. The argument, therefore, is that the capability of UK forces to conduct expeditionary warfare has been so compromised that Moore's law has come to pass.

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[8] SDR White Paper, 8 July 1998.
[9] Insert reference to SDSR 2010 and the decision to mothball one carrier and radically cut the air group.
[10] Insert reference to RAND report on lessons learned from Astute.
[11] Reference Moore's Law from Norwegian study.
[12] SDR White Paper, 8 July 1998.
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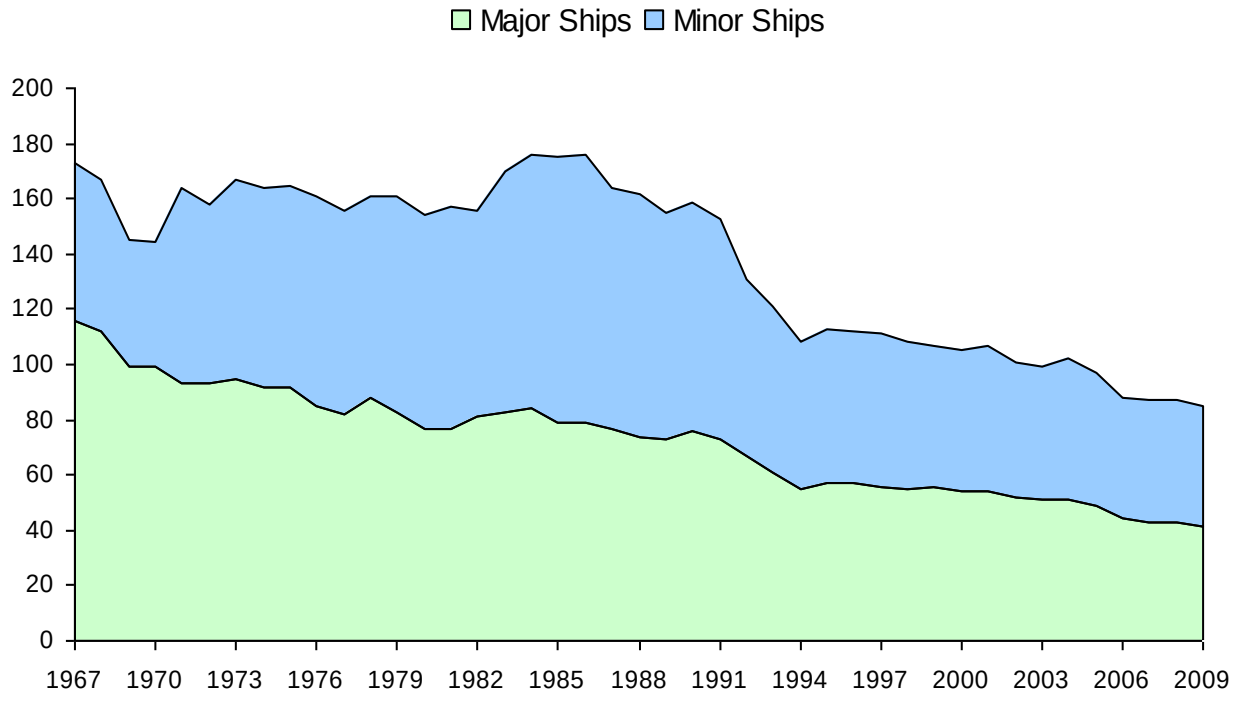
Figure 3: Number of Active Royal Navy Ships



[15] Reference Moore's Law from Norwegian study.

3.3 Other European Nations

3.3.1 Much the same applies for France in relation to its own Navy. The 2013 Defence Review – the first for 20 years – defined a force not dissimilar to that of the UK, with 10 nuclear submarines, 15 'first rank' frigates and 3 amphibious assault ships.[16] Nonetheless, a second planned carrier was cancelled, as was a fourth assault ship, reversing decisions made at the previous 2008 Defence Review, which suggested both were under consideration.[17] It should be noted, however, that the French Navy - unlike the RN - does possess a carrier strike capability as of 2015, but the *Charles de Gaulle* was in refit before this time, so that it offers an intermittent capability as a single carrier. As with the RN, French carrier strike is a discretionary capability.

3.3.2 In other respects the analogies between the French Navy and the RN are also striking. The French *Horizon* air defence frigates have their origins in the Common Next Generation Frigate (CNGF), which was a tri-national Franco-Italian-UK programme in the 1990s, from which the UK withdrew in 1999 to build the Type 45 destroyer. Just as with that programme (which proposed originally to build 12 destroyers but ended with only 6 being constructed), the French and Italian Navies both planned to acquire 4 of the Horizon class originally, but have both procured 2 each.[18] This halving of the original order in all three cases is very striking, and there is also a parallel between the reduction in the number of escorts between France and the UK. Between the French White Papers of 2008 and 2013, the number of front line frigates fell from 18 to 15 (this excludes 6 less powerful surveillance frigates), in a similar way to the decrease in the number of escorts for the RN between 1998 and 2010.

3.3.3 Brune examines the restricting of the armed forces of four major European states in the wake of the financial crisis, looking at each individually.[19] In the UK it is suggested that due to the rising costs of equipment the MoD has struggled to keep up with both the demands placed upon it since 1990 and the pace of technological change. Delays to projects and economies made on those Cold War legacy programs that have continued have ameliorated some costs in the short term but will likely push them higher in the long term. The effects of austerity and already planned drawdowns in budgets and capabilities, the paper suggests, are rapidly putting the UK defence budget under considerable pressure. Restrictive contracts that are more expensive to cancel than to pursue and delays to the procurement of large projects such as the Trident replacement or the Typhoon will likely lead to continued increases in the costs of procuring equipment, particularly in the 2020s.

3.3.4 The French have seen quite large budget cuts since 2010, but this has had few political ramifications as the French public are, by and large, disinterested in defence as a political issue. In terms of industry the French *Direction générale de l'armement* (DGA) has had to call upon and, in some cases, try and coerce companies in which it has a stake to make efficiencies or mergers where the market is too small. Rising costs of equipment such as the Rafale and the A400M are expected to make budget commitments difficult for France's Defence Ministry and the modernization of Mirage 2000 fighter jets is likely being delayed.

3.3.5 German acquisitions have come out heavily in favour of buying more military and commercial off-the-shelf equipment rather than investing in development of new technology. The paper states that this is in response to large planned cuts to the equipment budget and a number of large programmes being partly or entirely cancelled, with much of the equipment going up for sale internationally (particularly in terms of aircraft such as NH-90 and Tiger attack helicopters and Typhoons as well as naval vessels such as F125 and Type 122 frigates).

[16] French White Paper: Defence and National Security 2013.
[17] French White Paper: Defence and National Security 2008.
[18] See Jane's Fighting Ships 2013-14.
[19] Restructuring Europe's Armed Forces in Times of Austerity: The United Kingdom, France, Germany and Poland (Brune et al, RUSI/IRIS/PISM/SWP, 2010):

3.3.6 Poland's budget has suffered cuts and its industrial sector, largely state owned under the "Bumar" holding, has also suffered greatly because of this due to Poland's lack of exports, thus making the Polish Defence Ministry largely its only customer. Nonetheless Poland has embarked upon an ambitious procurement programme, mostly commercial off-the-shelf options from other nations but with an eventual aim to "Polandize" procurement and broaden exports.

3.3.7 It is interesting to note that the UK seems to be the only one of the four states that has pushed ahead with many projects it has already invested in, by delaying rather than postponing them (as France has done), despite the increased costs whilst both Germany and Poland have considered the affordability of COTS options more widely. It seems as though the UK is the only one of the four that has not really put measures in place to deal with issues caused by rising procurement costs after the financial crisis.

3.4 Operating and Maintenance Costs

3.4.1 Although the UK and USA have long claimed to base acquisition decisions on analysis of Whole Life Costs, there is limited data on intergenerational operating and maintenance costs over time. Manning figures provide one proxy measure of operating and support cost. For most UK naval platforms crew compliment figures were on broadly a rising trend up to the penultimate or immediate predecessor platform introduced into service. However, the latest platforms have substantially fewer crew numbers than the platform they replaced. The same applies to German Frigates. For details see Annex D.

3.4.2 This suggests that for the UK and German navies, manning levels were positively associated with capability and cost until fairly recently. However, there would appear to be a more recent attempt to design the latest platforms to be more manpower efficient and need fewer staff to operate them.

3.4.3 Annex H provides an analysis of O&M costs for the Royal Navy since 1989 and of selected European countries overall O&M budgets between 2005 and 2013. It is readily apparent that in the Royal Navy, O&M costs increased sharply between 1989 and 1995 as every single available cost in 1995 experienced an upwards surge in relation to its predecessor. The UK O&M budget rose substantially in real terms over the period since 2005, in marked contrast to the O&M budgets in France, Spain and Italy where it has risen modestly (France), stagnated (Spain) or fallen sharply (Italy). Without detailed information on unit O&M costs it is difficult to draw definitive conclusions about whether O&M costs have exhibited different rates of real terms growth in these countries or whether there has been merely a difference in the willingness and ability of Governments to accommodate O&M costs. We incline to the latter view.

4 Tackling Cost Growth

4.1 Summary of UK Evidence

4.1.1 An examination of the National Audit Office (NAO) Major Projects Reports from between 2005 and 2014 demonstrates both the challenges of defence equipment growth and some success in managing costs. For example, the 2011 Report noted that the increase in project costs for those approved before 2001 was 16.8%, compared to an increase of only 2.8% for those approved after 2001, and thereby demonstrating improvement in controlling costs. Nonetheless, it was noted that this had only been achieved by cutting the numbers of platforms, and thereby saving between £7.2Bn and £8.8Bn, or between 8.2% and 9.5% of the overall costs.[20] Therefore, although a tighter control on overall budgets is being maintained, the result is the acquisition of smaller numbers of platforms.

4.1.2 The 2011 Report also noted, more widely, that technical issues in the design and implementation of equipment led to cost growth, reduction in numbers of platforms, and slowing projects down to remain affordable.[21] This latter tendency was heavily criticised in 2009 by the NAO, such that "attempts to balance the defence budget in the short term have increased overall costs on projects, and slipped the introduction or reduced capability, which represents poor value for money."[22] The MOD made a concerted effort to tackle this issue following the 2010 SDSR, as noted by the NAO, although the problem has not been entirely eradicated due to the continuing impact of equipment cost increases.

4.1.3 The NAO have also noted a tendency for the MOD to prioritise performance requirement over cost, time into service or number of platforms acquired. In 2012 they noted that the MOD expected to achieve 99 per cent of its equipment capability specifications, but average project costs have risen by nearly 12 per cent and projects have been delayed by nearly 30 per cent since the main investment decision.[23] This emphasis on trading cost against time to achieve performance results in reduced numbers in a fairly systematic fashion. In addition the NAO have noted that larger approval values generally suffer disproportionately high cost growth.[24] This is evident in the high cost overruns experienced by the Queen Elizabeth Class carriers, Type 45 destroyers and Astute submarines, recorded across several of the Major Project Reviews.

4.2 Evidence for Continental European Countries

4.2.1 Evidence for Continental European Countries about the extent of the problem of cost growth is, with the notable exception of Norway, far more limited than for the UK. This does not necessarily mean there is any less of a problem; merely that it has attracted less attention. Neither have the Continental European Countries gone through multiple attempts to reform their procurement organisations as the UK has.

[20] Major Projects Review 2011, NAO, 16 November 2011, p.19.
[21] Major Projects Review 2011, NAO, 16 November 2011, p.20.
[22] Major Projects review 2009, NAO, 15 December 2009, p.11.
[23] Major Projects Review 2012, NAO, 10 January 2013.
[24] Major Projects Review 2013, NAO, 13 February 2014.

4.3 Tackling Cost Growth through Acquisition Reform

4.3.1 The UK has undertaken a series of acquisition reforms in an attempt to overcome the twin problems of cost over-runs and delays in delivery- see Annex G. Despite many repeated attempts, the review carried out by the Chief of Defence Material- Bernard Gray found the overall cost overrun for the equipment budget was around £35bn and that projects were, on average, expected to be delayed for 5 years. The factors responsible were- the increasing cost above inflation of defence equipment, issues with single service optimisation, lack of incentives to veto programmes put before the equipment board or to account for long-term cost increases, poor estimation of the cost of complex systems and a lack of accountability and financial planning.

4.3.2 Gray compared how the UK performs statistically in relation to the USA, Australia, France and other states with similar defence infrastructure. France's acquisition processes, which are much simpler than the UK's, are said to involve a more straightforward way of developing and approving equipment acquisitions, avoiding some of the difficulties in the UK. Australia, who have a very similar process to the UK but differ in that they have to consider at least one Commercial Off the Shelf (COTS) option when they look at acquiring new defence equipment and have an accelerated approvals phase for low-risk projects, also seem to suffer from both a number of the same issues as the UK as well as a general lack of defence infrastructure, particularly in industry and personnel. Canada has a slightly simpler system than the UK and a much clearer definition between supplier and customer.

5 Reponses and Implications for Nations

5.1 The Problem

5.1.1 The starting point is to recognise the reality of defence equipment cost escalation, as demonstrated by the studies surveyed in this report. A number of semi-independent factors contribute to this escalation, although they are linked into a vicious circle:

- the differential between defence inflation and CPI/ GDP deflator inflation;
- inter-generational unit cost escalation;
- the deleterious financial impact of buying fewer platforms within a given class or type;
- the various behavioural issues causing project price estimates to be initially understated;
- the reduction of the competitive market for many defence platforms;
- and the way in which budgetary difficulties are tackled by delaying projects.

5.1.2 It has to be recognised that these factors need to be tackled differently. It needs to be recognised that new management systems are unlikely to deliver reduced costs. Most countries also need to address behavioural distortions (eg Optimism bias) amongst their procurement organisations.

5.2 Possible Responses

5.2.1 A number of potential responses exist:

- Try to address the perverse incentives encouraging project optimism bias and lack of responsibility for managing costs. Improve acquisition planning by recognising the reality of cost escalation and delivering more realistic estimates, or at least testing them with what would happen if costs overran (for example, would it result in reduced numbers of platforms, delays, performance or other compromises to capability?).
- When trading cost, time and performance, be willing to reduce the latter to ensure projects are on time and to cost. Although performance is important, there is a point at which capability becomes intermittent or compromised.
- Attempt to specialise roles on a national basis. The Danes removed their submarine capability in the 2000s and it could be more effective to lose a capability completely, to enable others to be funded properly, rather than to deliver compromised capabilities across the board.
- Consider different ways of delivering capability. Projecting air power, for example, may be done not through unaffordable carriers and manned fast jets, but instead by small UCAVs launched from existing smaller naval platforms. There will be a need to look at a wider option set at the start of individual acquisition programmes. In many cases this will involve building simpler platforms (for example the Royal Navy's HMS Ocean was not late or over budget, built using commercial standards), faster. In other cases this will mean buying more off the shelf. In any case there will be a need to avoid the very lengthy gestation periods that have been associated with both the France's Charles DeGaulle carrier and the UK's QE2 class carriers. In the latter case the underpinning policy behind the requirement- that of the UK's expeditionary warfare has come and gone while the carriers were still being built.
- Be willing to buy off the shelf, or to consider COTS as with the Australian model, for at least some purchases, perhaps reducing sovereign capability, but being realistic that not all capabilities can be protected at the national level.

- Aim to cut the timescales for platform development, and to ensure that platforms and systems are flexible and can be updated or have their role changed: if 20 years is required to build a platform from conception to entering service, such adaptability is essential.

5.3 Conclusions

5.3.1 Our conclusions are as follows-

- The literature and the evidence is emphatic: defence equipment cost escalation is real
- It stems from the 'tournament goods' nature of defence equipment, leading to defence inflation greater than CPI and intergenerational cost escalation
- Once in train, it then reduces the number of platforms in a class, introduces delays to manage affordability, and shrinks the market, leading to a vicious circle of further cost increases
- Its effects result in compromised or intermittent capability, often delivered decades after the requirement for the platforms was established
- Ignoring the problem will not make it go away: the policy, strategic direction and approach of the MOD needs to change
- None of the potential solutions would be easy to implement, but must be to deliver better VfM and more durable and effective capability

Annex A

A.1 Approaches to Analysis

A.1.1 Two alternative approaches have been deployed in the literature to measure the scale of Intergenerational cost escalation. The first method, deployed in Davies et al, used was a "top-down approach" using a reducing balance method. Stock numbers were available for Naval vessels from 1960-2009 but aircraft needed to be imputed from production numbers together with an assumed attrition rate. A solver equation was then used to estimate the cost escalation rate based on the decline in stock numbers. The results suggest average real intergenerational cost growth of between 3½% and 6% with around 3½% for Naval Vessels and tanks, around 5 to 6% for aircraft.

A.1.2 The second and more common approach involved constructing a time series of equipment procurement looking at the unit production costs of defence equipment. Data for early equipment types may not factor in the true costs of production as the defence industry was nationalised. Earlier estimates do not specify if the costs include all of the weapons systems e.g. defence estimates of ships during the 60's and 70's.

A.1.3 The second approach has necessarily tended to be focused on "major" equipment types only. Davies et al looked at frigates, submarines, destroyers, aircraft carriers, fighter aircraft and main battle tanks.

A.1.4 Davies et al draw their data from Hansard Parliamentary Questions, Jane's publications and NAO reports. They assembled data for Royal Navy Frigates, Destroyers, Aircraft Carriers, Hunter and Ballistic Missile Killer Submarines from the mid-1950s through to 2011. For Royal Air Force combat aircraft from the mid-1950s through to 2008 and for Transport aircraft from 1966 to 1984 and trainer aircraft from 1976 to 2008.Finally for Main Battle Tanks from 1963 to 1994. This data was re-based to2009 prices using the UK GDP deflator measure of economy wide general inflation. The charts in Annexe 1 summarise the data on costs by category of equipment.

A.1.5 Hove and Lillekvelland created a table "of 280 observations of prices and characteristics" for various different pieces of military equipment, distinguishing between costs with research and development (R&D) production taken into account and those without. This difference can be important in those cases, such as the F22, where R&D costs significantly affect total unit costs. Finally there are difficulties identifying what constitutes a particular weapons system since a number of them (such as the distinction between a corvette and a frigate) are arguably classified according to characteristics that fluctuate greatly today.

A.2 Analysis

A.2.1 Both Hove and Lillekvelland and Davies et al analyse Intergenerational Cost Escalation with defence equipment through the use of multiple regression analysis. Hove and Lillekvelland discuss the weakness of some of the data due to gaps in the time series dataset, multicollinearity that causes instability in their correlated regression coefficients, the size of sample for each weapon system being quite small (reducing the precision of estimates) and autocorrelation resulting in biased OLS standard deviations.

A.2.2 They also discuss other possible methods for ICE estimation such as ridge Regression (RR), Partial Least Squares (LPS) and Principal component Regression (PCR).Their results are as follows;

SYSTEM	Intergenerational Cost Escalation (pa)	Residual ICE (pa)
Transport aircraft	7.4%	3.1%
Fighter aircraft	7.0%	3.9%
IFVs	5.2%	2.1%
Artillery vehicles	4.5%	
Submarines	4.5%	1.7%
FACs (incl MTBs & corvettes)	3.6%	0.5%
Helicopters	2.5%	0.6%
Frigates	2.4%	0.8%
MBTs	2.1%	1.1%
Small Arms	1.2%	

A.2.3 Hove and Lillekvelland compare their results with those of the previous studies examined in their report. They also provide a further explanatory note on variation over time and how historical circumstances (such as the Cold War "thaw" between 1962 and 1979 or the America's decade of near hegemony in the 1990s) over the time being examined may have affected ICE more generally due to shifting military requirements. Additionally they state it is worth noting the importance of those technologies that make vital equipment near obsolete and the effect of "critical mass", where systems become so expensive only a handful of nations can afford them, on ICE trends over time.

A.2.4 The main findings on the rates of Intergenerational Cost Escalation in Davies et al are as follows:

Platform Type	Period	OLS Time Trend	Compound Function
Destroyers	1962-2010	3.74%	2.50%
Frigates	1956-2000	4.56%	4.11%
Aircraft Carrier	1955-1985	3.41%	5.53%
Diesel Submarine	1964-1990	2.80%	2.56%
Nuclear Submarine	1963-1983	2.75%	2.26%
Ballistic Submarine	1967-1999	4.14%	4.30%
Combat Aircraft	1955-2008	6.07%	6.52%
Transport Aircraft	1966-1984	5.80%	8.09%
Trainer Aircraft	1976-2008	-1.48%	-2.20%
Main Battle Tanks	1971-1994	6.08%	6.66%

Annex B Royal Navy Ships and Aircraft 1960 – Present

B.1 Aircraft Carriers:

- Queen Elizabeth Class CVA-01 (Cancelled, 1960s)
- Invincible Class (3 Completed, 1980s – 2014)
- Queen Elizabeth Class (2 Under Construction, 2016 -)

B.2 Amphibious Warfare:

- Fearless Class (2 Completed, 1965 – 2002)
- Albion Class (2 Completed, 2003 – Present)

B.3 Cruisers:

- Tiger Class (3 Completed, 1959 – 1979)

B.4 Destroyers:

- County Class (8 Completed, 2 Cancelled, 1962 – 1980)
- Type 82 (1 Completed, 3 Cancelled, 1973 – Present)
- Type 42 (16 Completed, (1971 – 2013)
- Type 45 (6 Completed, 2009 – Present)

B.5 Patrol Vessels:

- Archer Class (16 Completed, 1985 – Present)
- Scimitar Class (2 Completed, 2003 – Present)
- River Class (5 Completed, 8 Planned, 1 Under Construction, 2001 – Present)

B.6 Frigates:

- Leander Class (26 Completed, 1963 – 1990s)
- Type 81 (7 Completed, 1961 – 1984)
- Type 21 (8 Completed, 1974 – 1994)
- Type 22 (14 Completed, 1979 – 2011)
- Type 23 (16 Completed, 1987 – Present)
- Type 26 Global Combat Ship (13 Planned, Expected 2022)

B.7 Mine Countermeasures Vessels:

- Wilton Class (1 Completed, 1972 – 1994)
- Hunt Class (13 Completed, 1979 – Present)
- River Class Minesweeper (12 Completed, 1984 – 2001)
- Sandown Class (15 Completed, 1989 – Present)

B.8 Submarines:

- Oberon Class (27 Completed, 1960 – 2000)
- HMS Dreadnought (1 Completed, First Nuclear Powered Submarine, 1963 – 1980)
- Valiant Class (2 Completed, 1966 – 1994)
- Resolution Class (4 Completed, 1968 – 1996)
- Churchill Class (3 Completed, 1970s – 1990)
- Swiftsure Class (6 Completed, 1973 – 2010)
- Trafalgar Class (7 Completed, 1983 – Present)
- Upholder Class (4 Completed, 1990 – 1994)
- Vanguard Class (4 Completed, 1993 – Present)
- Astute Class (2 Completed, 7 Planned, 4 Under Construction, 2010 – Present)

B.9 Aircraft:

- Blackburn Buccaneer (211 Completed, 1962 – 1978)
- F-4 Phantom II (185 Completed, Bought From USA, 1969 – 1992)
- Sea Harrier (111 Completed, 1978 – 2006)
- Harrier II (143 Completed, 1989 – 2011)

B.10 Helicopters:

- Westland Wasp (133 Completed, 1962 – 1988)
- Westland Sea King (344 Completed, 1969 – Present)
- Westland/Aerospatiale Gazelle (310 Completed, 1974 – 2012)
- Westland Lynx (450 Completed, 1978 – Present)
- AgustaWestland AW101 Merlin (44 Completed, 1999 – Present)
- AgustaWestland Apache (67 Completed, US Licensed, 2004 – Present

Figure 1 - Aircraft Numbers 1960 - 2010

Annex C Platform costs over time

C.1 Fighter Jets

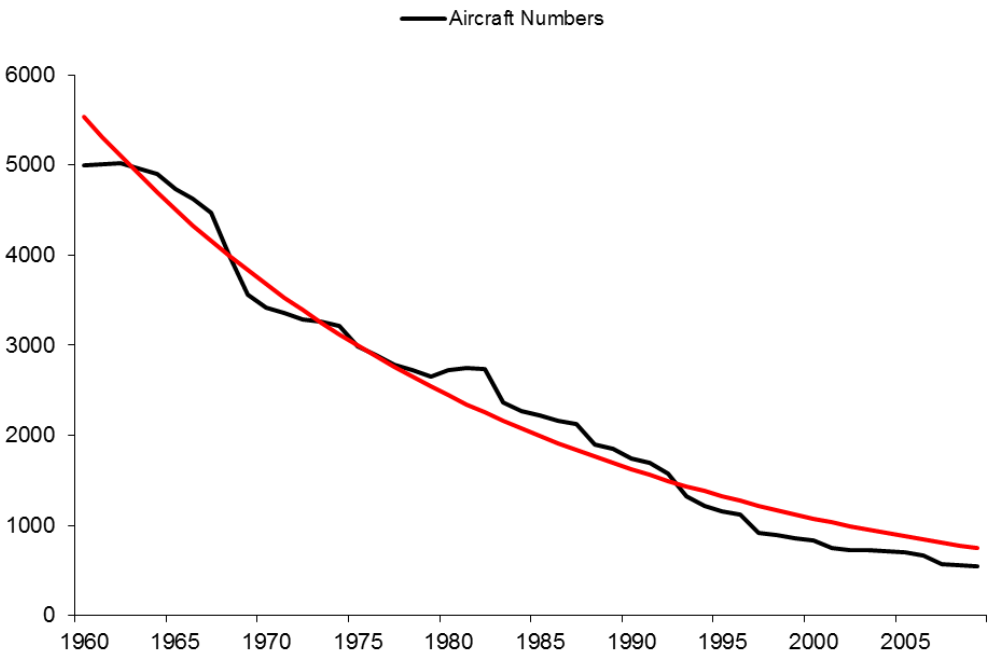


Figure 2 - Aircraft Numbers 1960 - 2010

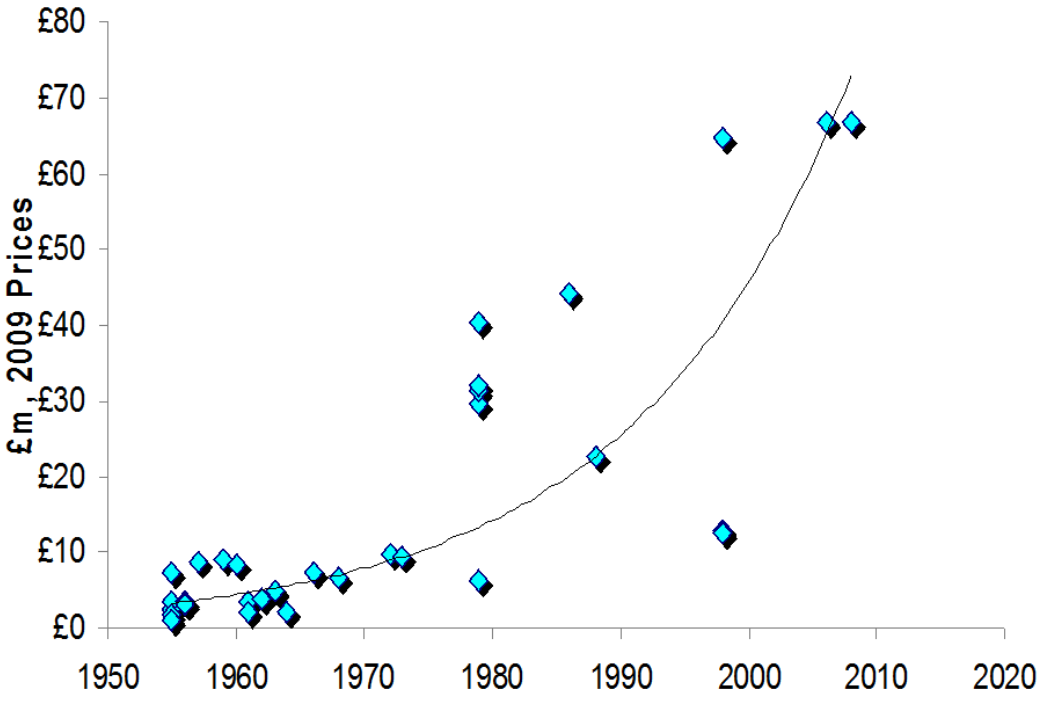


Figure 3 - Fighter jet costs over time

C.2 Frigates

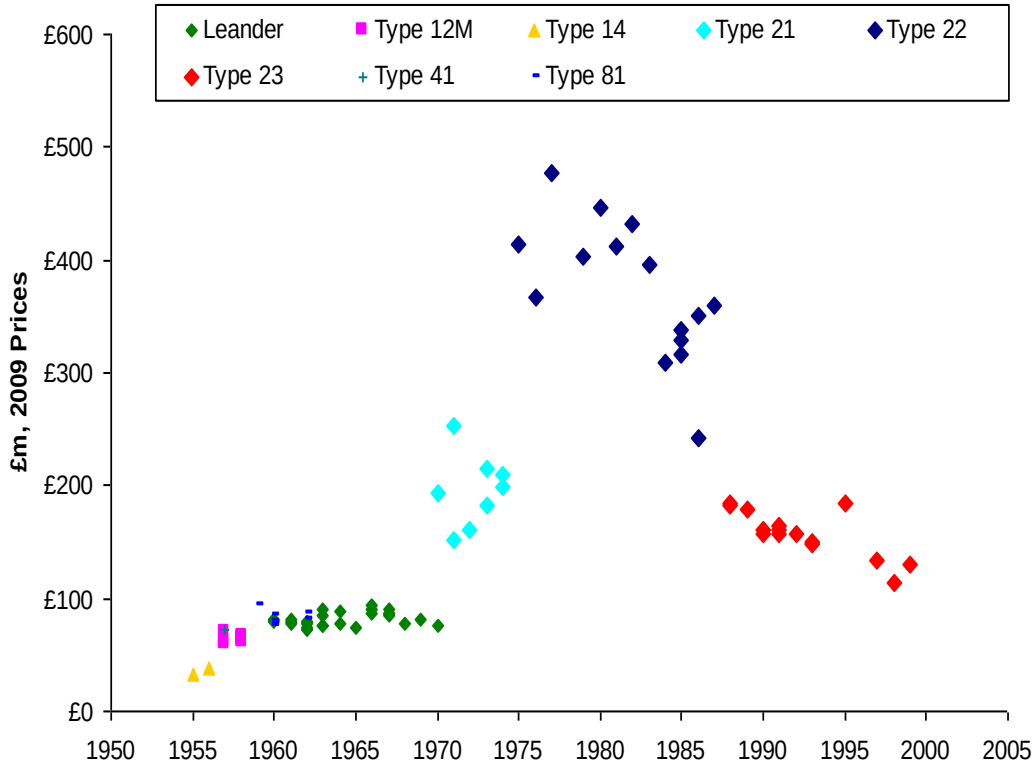


Figure 4 - Frigate costs over time

C.2.1 Notes on Frigates

- Type 22/23 both show the effects of learning.
- Type 22 suffered large cost over-runs.
- Cost may have been driven by increases in capability and weight:
- Leander – 2500 tn
- Type 21 - 2750 tn
- Type 22 – 4400-5300 tn
- Type 23 – 4800 tn

C.3 Aircraft Carriers

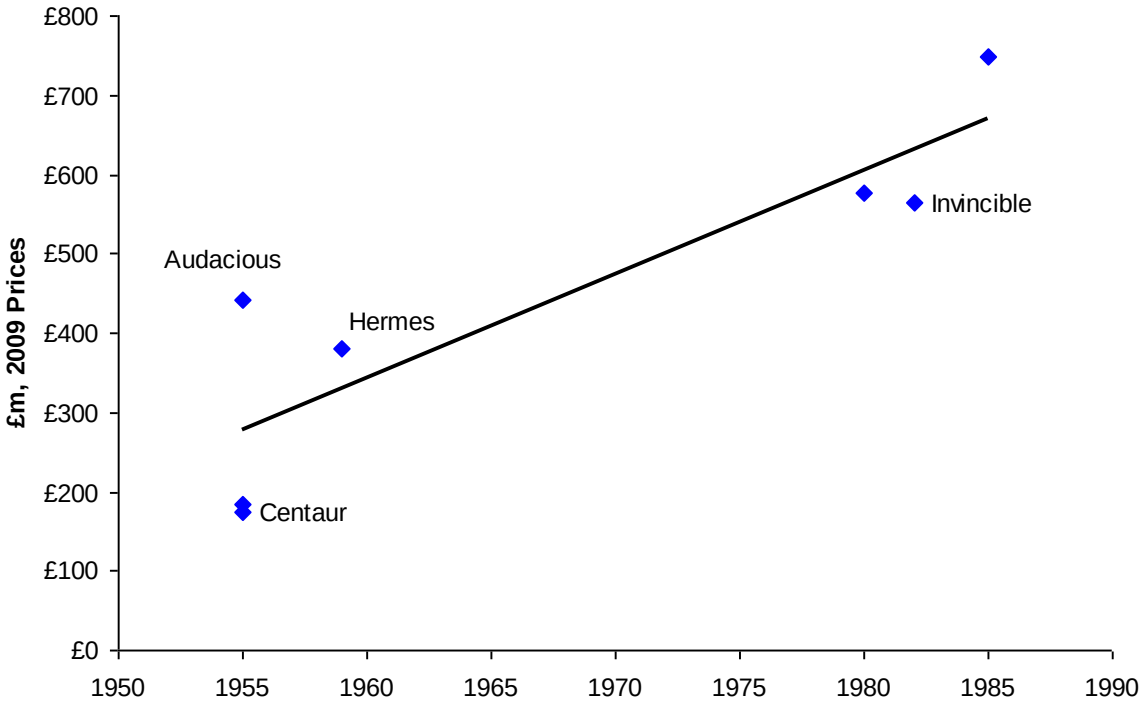


Figure 5 - Aircraft Carrier costs over time

5.3.2 CVF: The CVF involved an explicit attempt by the UK MOD to try to constrain the unit cost through setting a budget that ultimately proved wholly unrealistic and a new "alliance" structure of bringing together both the MOD Project Team and Suppliers into a single team to manage the project. The MOD deliberately departed from its normal policy of constraining defence inflation through prescribing the use of output rather than input price indices in the Variation of Price clause applied to the CVF contract target price to get industry to sign up to the budget.

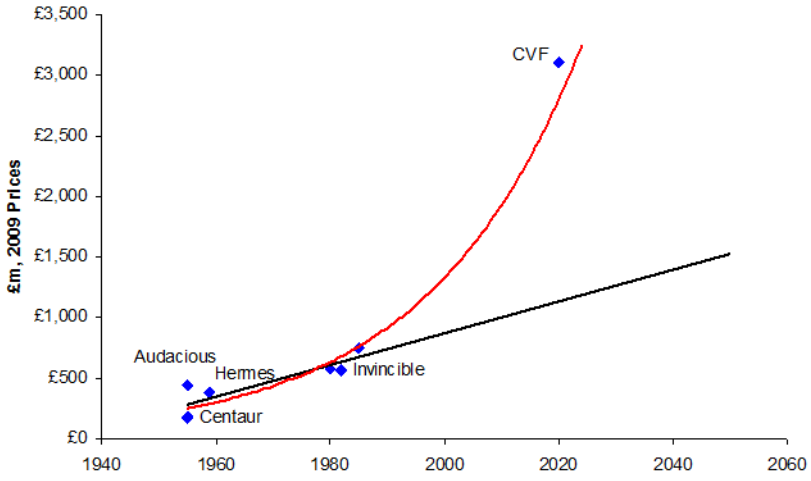


Figure 6 - Aircraft Carrier minus CVF

C.4 Main Battle Tanks

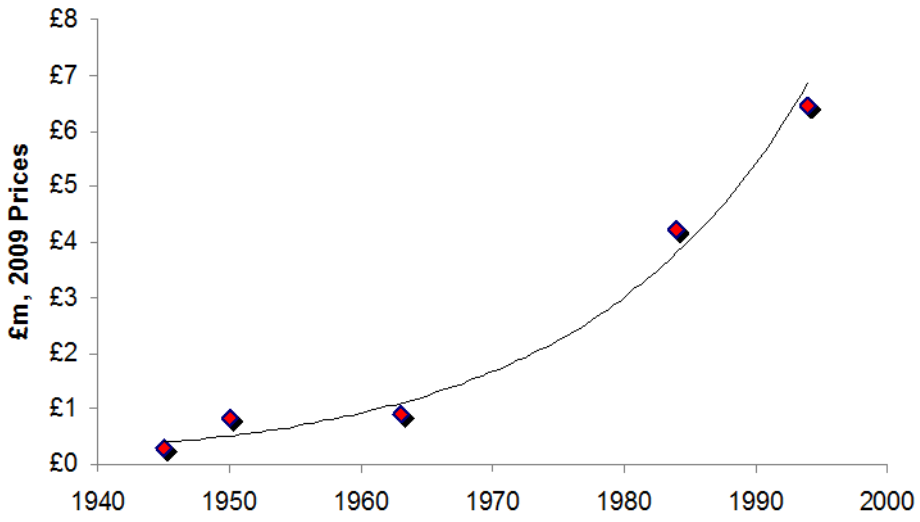


Figure 7 - Main Battle Tank costs over time

Annex D O & M Costs and Platform Crew Numbers

D.1 Platform crew number tables

Germany (Frigates)	Crew	France (Frigates)	Crew	France (Carriers)	Crew
Koln Class (1964)	200	Commandant Riviere Class (1971)	167	Clemenceau Class (1963)	1,338
Bremen Class (1990)	219	Type A69 Class (1981)	79	Charles De Gaulle Class (2001)	1,862
Brandenburg Class (1996)	243	D'estienne Dorves Class (1986)	108		
Sachsen Class (2005)	255	Floreal Class (1994)	83		
Baden-Wurtemberg Class (2018)	170	La Fayette Class (2001)	178		

UK (Frigates)	Crew	UK (Carriers)	Crew	UK (Destroyers)	Crew
Whitby Class (1960)	225	Queen Elizabeth Class (1966)	-	Battle Class (1947)	247
Salisbury Class (1960)	235	Invincible Class (1980)	900	Daring Class (1954)	297
Rothesy Class (1961)	152	Queen Elizabeth Class (2016)	1,377	County Class (1962)	471
Type 81 Class (1961)	253			Type 82 (1973)	397
Leander Class (1963)	260			Type 42 (1975)	253
Type 22 (1979) Batch 1	222			Type 45 (2010)	191
Type 22 (1979) Batch 2	275				
Type 22 (1979) Batch 3	250				
Type 21 (1974)	177				
Type 23 (1987)	185				
Type 26 (2022)	190				

UK (Attack Submarines)	Crew	UK (SSBNs)	Crew
Dreadnought Class (1963)	113	Resolution Class (1968)	143
Valiant Class (1966)	103	Vanguard Class (1993)	135
Churchill Class (1970)	103		
Swiftsure Class (1973)	116		
Trafalgar Class (1983)	130		
Upholder Class (1990)	59		
Astute Class (2010)	98		

Table 1 - Platform Crew Numbers

Annex E Projects That Experienced Significant Problems with Delays, Cancelations and Cost Overruns

E.1 List of platforms/projects that experienced issues

1 **Queen Elizabeth Class** (1960): Cancelled in a 1966 white paper on defence by the Labour government of the time. It was seen as unnecessary for a post-imperial Britain and at a time of economic uncertainty[25]. Frequent serious design issues and a dwindling budget for the project plus inter-service rivalry meant it never went to the construction phase[26].

2 **Tiger Class Cruiser** (1960): Construction initially began in the 1940s as the Minotaur class; most were cancelled or scrapped until the mid-1950s. After numerous delays they finally entered service in 1960. Only three ships were eventually created and all had relatively short operational life spans before being put in reserve.

3 **Type 81 Frigate** (1960): Thirteen out of twenty ships ordered were cancelled. Cost of each ship was significantly greater than initially projected.

4 **Blackburn Buccaneer Fighter** (1962): Suffered a number of accidents due to design flaws (notably insufficient engine power). This was fixed at extra cost.

5 **County Class Destroyer** (1962): "Sea Slug" missile the ships were originally based around did not perform as expected, but was continued so that the much improved "Sea Dart" missile could be developed. Two were cancelled and the six completed were heavily modified from original designs.

6 **Type 42 Destroyer** (1971): Delays due to problems with the early ships due to hull problems in trials. The early ships ran over budget from an initial figure of £19m per ship to £23m for the first constructed.

7 **Type 82 Destroyer** (1973): Three of the four planned ships were cancelled as a result of the cancellation of the Queen Elizabeth class in 1966. The government took undue time to decide upon the cancellation[27], causing delays and cost overruns.

8 **Type 21 Frigate** (1974): Cost overruns on the first of the class, Amazon, went from a £3m initial budget to £14m by the time it entered service.

9 **Type 22 Frigate** (1979): Initially estimated at £30m, but delays and high inflation brought the cost of the first of the class up to almost £68m.

[25] James, D. R. (January 1999). "Carrier 2000: A Consideration of Naval Aviation in the Millennium - I" (PDF). The Naval Review 87 (1): 3–8
[26] Nick Childs (3 July 2014). "The aircraft carrier that never was". BBC.
[27] Hansards, http://hansard.millbanksystems.com/commons/1967/mar/01/type-82-destroyers

10 **Archer Class Patrol Vessel** (1985): Initial Company contracted to build them went into liquidation, works had to be completed elsewhere.

11 **Type 23 Frigate** (1987): Initial unit cost in 1980 was given as £75m, by 1984 this was £110m[28]. By 1990, when the first unit entered service the cost had become over £135m[29].

12 **Upholder Class Submarine** (1990): A number of design flaws meant that extra costs were incurred after construction.

13 **Merlin Helicopter** (1999): Maintenance problems have been an issue and, since coming into active service, Merlin's have been considerably more expensive to maintain than initially thought[30].

14 **AgustaWestland Apache Helicopter** (Licensed from USA, 2004): Capability delayed for two years and at unforeseen costs of over £24m, MoD accused of poor management over the project and the capability was much more maintenance heavy and expensive to utilize than first anticipated[31].

15 **Type 45 Destroyer** (2010): Three years late and £1.5bn over budget[32].

16 **Astute Class Submarine** (2010): Massively delayed and over budget, an extremely troubled project throughout the 2000s. The cost increased by over 50% and the programme was delayed for almost five years[33].

17 **Queen Elizabeth Class** (2016): Not yet completed but spiralling costs (from £3.9bn to £6.2bn), delays, untimely decisions (particularly on the installation of steam catapults) and a lack of aircraft for the platform have been criticized[34].

18 **Type 26 Global Combat Ship** (Expected 2022): Difficulties with agreeing a deal to build the Type 26 with BAE[35] and issues surrounding the decision to build all thirteen ships on the Clyde[36]. Both of these problems have the potential to cause delays and cost increases.

[28] Hansards, http://hansard.millbanksystems.com/written_answers/1985/jan/11/type-23-frigates
[29] Hansards, http://www.publications.parliament.uk/pa/cm200102/cmhansrd/vo010705/text/10705w05.htm
[30] Defence Industry Daily, "Britain's Bottom Line(s)", Defence Industry Daily. http://www.defenseindustrydaily.com/2-bn-for-british-eh101-merlin-multirole-upgrades-01745/
[31] Hansards, "FORTY-SIXTH REPORT: MINISTRY OF DEFENCE-BUILDING AN AIR MANOEUVRE CAPABILITY: THE INTRODUCTION OF THE APACHE HELICOPTER (HC 533)", House of Commons. http://www.parliament.uk/business/committees/committees-archive/committee-of-public-accounts/pac181103-pn46/
[32] Public Accounts Committee Report, http://www.publications.parliament.uk/pa/cm200809/cmselect/cmpubacc/372/37205.htm
[33] House of Commons Defence Committee, "Defence Equipment 2010", House of Commons. http://www.publications.parliament.uk/pa/cm200910/cmselect/cmdfence/99/99.pdf P. 97
[34] Caroline Wyatt (4 July 2014), "The true cost of aircraft carrier HMS Queen Elizabeth", BBC
[35] Andrew Chuter, "Britain Struggles With Costs for New Frigates", Defence News. http://www.defensenews.com/article/20141109/DEFREG01/311090024/Britain-Struggles-Costs-New-Frigates
[36] Severin Carrell, "Michael Fallon overrules Royal Navy head over Scotland's shipyards", The Guardian. http://www.theguardian.com/politics/2014/nov/12/michael-fallon-royal-navy-frigate-clyde-scotland-shipyards-zambellas

Annex F Tables showing problems with the 18 identified Royal Navy platforms

F.1 Key

F.1.1 Green = No

F.1.2 Red = Yes

F.1.3 White = Unknown

Aircraft Carriers	*Queen Elizabeth Class (1966)*	*Queen Elizabeth Class (2016)*
Delayed?		
Over Budget?		
Units Cancelled?		

Cruisers	*Tiger Class (1960)*
Delayed?	
Over Budget?	
Units Cancelled?	

Frigates	*Type 81 Class*	*Type 21 Class*	*Type 22 Class*	*Type 23 Class*	*Type 26 Class*
Delayed?					
Over Budget?					
Units Cancelled?					

Destroyers	*County Class*	*Type 42 Class*	*Type 82 Class*	*Type 45 Class*
Delayed?				
Over Budget?				
Units Cancelled?				

Patrol Vessels	*Archer Class*
Delayed?	
Over Budget?	
Units Cancelled?	

Submarines	*Upholder Class*	*Astute Class*
Delayed?		
Over Budget?		
Units Cancelled?		

Helicopters	*Merlin AW101*	*AgustaWestland Apache*
Delayed?		
Over Budget?		
Units Cancelled?		

Aircraft	*Blackburn Buccaneer*
Delayed?	
Over Budget?	
Units Cancelled?	

Annex G UK Attempts to Reform Defence Acquisition

G.1 The UK has undertaken a series of acquisition reforms in an attempt to overcome the twin problems of cost over-runs and delays in delivery. In date order these were:

- Gibb-Zukerman report (1961)
- Downey Steering Group on Development Cost Estimates (1968)
- Rayner report (1971)
- Levene reforms (from 1985)
- Managing Major Projects in the Procurement Executive report (1987)
- Smart Acquisition (1998)
- Development of the Procurement Executive into the DPA and
- formation of the DLO (1999)
- DLO Change Programme (2000)
- Merger of DPA and DLO into DE&S.
- The development of the Transformation Staircase in support.
- Initial implementation of the Defence Industrial Strategy (2005)
- Implementation of Through Life Capability Management ("TLCM") following on from the Enabling Acquisition Change report (2006).
- Implementation of PACE programme within DE&S to deliver improved Performance, Agility Confidence, and Efficiency as part of the wider Defence Acquisition Change Programme.

Annex H Operations and Maintenance Budgets (UK and European)

UK	O&M per ship per year (1976 prices)	O&M per ship per year (1989 prices)	O&M per ship per year (1995 prices)	O&M per ship per year (2000 prices)	Predicted O&M for these years (according to Defence Inflation Figures)			% Predicted O&M Over/Under Defence Inflation		
Type 42 Destroyer	£5.2m	£6m	£17.2m	£12m (1997)	£16.5m (1989)	£21.7m (1995)	£24.3m (2000)	-61% (1989)	-21% (1997)	-51% (2000)
Type 21 Frigate	£3.3m	£3.9m	-	-	£10.4m (1989)	-	-	-62% (1989)	-	-
Leander Class Frigate	£2.9m	£4.2m	-	-	£9.2m (1989)	-	-	-54% (1989)	-	-
Type 22 Frigate	-	£5.6m	£17.2m	£16m	-	£7.4m (1995)	£8.2m (2000)	-	+133% (1995)	+95% (2000)
Type 23 Frigate	-	£5.3m	£15.5m	£16m	-	£7m (1995)	£7.8m (2000)	-	+121% (1995)	+105% (2000)
Invincible Class Carrier	-	£21.4m	£35m	-	-	£28.1m (1995)	-	-	+21% (1995)	-
Fearless Class	-	£9m	£17m	-	-	£11.8 (1995)	-	-	+44% (1995)	-
Oberon Class SSN	£1.1m	£2.4m	-	£11m	£3.8m (1989)	-	£5.1m (2000)	-37%(1989)	-	+115% (2000)
SSBNs	£3.8m	£4.4m	£22.3m	-	£13m (1989)	£15.8m (1995)	-	-66% (1989)	+41% (1995)	-
Ton Class Minsweeper/ hunter	£0.3m	£0.8m	-	-	£1m (1989)	-	-	-20% (1989)	-	-
Hunt Class Minehunter	-	£0.9m	£3.5m	£3m	-	£1.2m (1995)	£1.3m (2000)	-	+191% (1995)	+130% (2000)
Sandown class Minehunter	-	-	£2.5m	£2m	-	-	£2.8m (2000)	-	-	-29% (2000)

H.1 UK Platform Data

H.1.1 This section takes data from a select number of points in time, with each platform being selected because data was found for at least two or more points in time so as to allow for comparison between the O&M spend on each platform over time.

H.1.2 The points in time with data available for the selected platforms are: are 1976, 1989, 1995 and 2000. It is felt that this represents a long enough time frame from which to draw interesting conclusions. The actual pricing data found has been compared to the rate of defence inflation from 1976 onwards to measure not only increases and decreases in the cost of O&M but also how much above or below inflation O&M was on those platforms examined.

H.1.3 It is readily apparent that prices for O&M increased sharply between 1989 and 1995 as every single available cost in 1995 experienced an upwards surge in relation to its predecessor. This could be due to the fact that all those platforms that had available data were either relatively new or relatively old, which may explain the increased costs in maintenance as the Royal Navy (RN) was still learning how to cost-effectively operate newer vessels and struggling to do the same for older ones. Additionally the strain on O&M arising from British military operations that had occurred or were occurring in Iraq (1990-91) and Bosnia (1992-1996 as part of UNPROFOR) may have also inflated costs across all services, including the RN.

H.1.4 This is also apparent in terms of defence inflation. In 1989 all those O&M costs investigated where data had been available from 1976 were significantly below defence inflation, however after 1995 and going into 2000 the vast majority of platforms were now significantly above inflation with some even seeing O&M costs at double or even triple that of expected defence inflation. Additionally these increases seemed to make little distinction between older and newer platforms, suggesting a general rise in the cost of O&M for the RN.

EDA O&M Budget Data	O&M Budget Total 2005	O&M Budget Total 2007	O&M Budget Total 2010	O&M Budget Total 2013
France	£4,996,000,000	£5,696,000,000	£6,198,000,000	£5,973,000,000
(% Change Between Years)	-	+14%	+8%	-4%
Defence Inflation Since 2005	-	£5,281,587,540	£5,707,849,105	£6,024,466,856
(% Difference with Actual Figures)	-	+8%	+8%	-1%
Italy	£2,256,000,000	£1,367,000,000	£1,371,000,000	£1,502,000,000
(% Change Between Years)	-	-39%	0%	+10%
Defence Inflation Since 2005	-	£2,384,960,266	£2,577,443,471	£2,720,415,778
(% Difference with Actual Figures)	-	-43%	-47%	-45%
Spain	£1,218,000,000	£1,430,000,000	£1,448,000,000	£1,452,000,000
(% Change Between Years)	-	+17%	+1%	0%
Defence Inflation Since 2005	-	£1,287,624,825	£1,391,545,278	£1,468,735,114
(% Difference with Actual Figures)	-	+11%	+4%	-2%
UK	£9,564,000,000	£11,494,000,000	£13,592,000,000	£14,058,000,000
(% Change Between Years)	-	+20%	+18%	+3%
Defence Inflation Since 2005	-	£10,110,709,214	£10,926,715,140	£11,532,826,463
(% Difference with Actual Figures)	-	+13%	+24%	+21%

H.2 European and UK O&M Budgets

H.2.1 This section takes data from the European Defence Agency (EDA) on a number of state's (France, Italy, Spain and the UK) changing O&M budgets at regular intervals between 2005, when EDA records began, and the most recent reporting in 2013. The data was measured in two ways, firstly in real terms by measuring the rate of increase or decrease in O&M budgets over time and secondly as a measure relative to Defence Inflation for the UK. Generally three of the four states budgets trended upwards until 2013 at which point all either stagnated, as in Italy, fell, as in France, or rose under inflation, as in Spain.

H.2.2 In real terms budgets rose above those levels seen in 2005 in Spain and the UK and even in France, where cuts to the O&M budget in 2013 of 4% did not reverse the increases of the previous eight years. The O&M budget of Italy saw huge cuts of 39% in 2007 and did not recover by 2013, despite the budget increasing by 10% on its stagnation in 2010; this may be due to the 2007 financial crisis, which hit Italy particularly hard or potentially because they withdrew forces from Iraq in 2006. Spain increased by 18% between 2005 and 2010 but has stagnated since 2013, likely due to the influence of the financial crisis on the Spanish economy. France maintained relatively generous increases in O&M budgets since 2005 but saw a decrease in 2013; this may be due to the reorganization of the French Defence Ministry and industry due to the 2007 financial crisis prompting budget cuts. The UK's O&M budget has continued to rise though these rises significantly lessened in 2013, down to a 3% increase from a high of 20% in 2005, this might suggest that the UK, though still willing to increase spending on its O&M budget, is struggling to cope with its increasing costs.

H.2.3 Relative to UK Defence Inflation Italian O&M budgets suffer greatly once again since 2005, remaining vastly under inflation (between 40-50%) over the period, this is very likely to be due to a lack of recovery more generally from the vast cuts of 2007. Spain, meanwhile, seems to struggle to keep its O&M budget above inflation as they move into 2013 despite having kept it as such between 2005 and 2011; this trend implies that Spain, whilst interested in maintaining its O&M

budget, has suffered from increasing costs for its equipment in a time of austerity. France too has seen a reduction in spending in relation to inflation figures since 2010; however this is again likely to be due to the reorganization of the French Defence Ministry and industry as the O&M budget only just dips below inflation after a small real terms decrease in spending. The UK, conversely, has seen a decrease in spending over inflation between 2010 and 2013 but otherwise an overall increase from the 13% above inflation spending in 2005 to 21% in 2013.

H.2.4 Having examined the data it seems clear that the UK is very different to other European states when it comes to budgeting for the O&M of its forces. Not only do we see rises in real terms between budgets but also above-defence inflation rises of between 13-24% since 2005, much larger than that of others. Additionally the UK's budget itself if far above that of those other European states examined, it being at least £6bn or more in real terms above its nearest competitor, France. This would suggest that the UK O&M budget is vast, even in regards to France, who have comparable forces, and that the escalation of this budget shows little or no signs of slowing its increases, even as other states tighten their belts.