BRITAIN
I. MISSIONS, MAJOR EQUIPMENT, AND MODERNIZATION REQUIREMENTS

This section describes U.K. defense missions, outlines major equipment assets\(^1\) and retirement rates, and reports Ministry of Defence plans\(^2\) for equipment modernization over the next seventeen years. It also presents estimates of the current production costs of major new equipment in order to compare these costs with projected resources available for major equipment in Section III.

The specific missions of the armed forces are to a great degree determined by the evolution of previous commitments.\(^3\) Current missions and strategy reflect this evolution, although specific missions today are described in former Secretary of State for Defence John Nott's 1981 defence review.\(^4\) Nott's review broadly outlined the major missions of the Royal Air Force, Royal Navy and Marines (RN/M), and the Army, and restated Britain's commitment to NATO. (95% of Britain's defense spending is devoted to NATO-related missions.) In the absence of any future formal defence review,\(^6\) these broadly outlined missions should change only marginally. Such marginal changes will result from "first order assumptions" which the Secretary of State for Defence provides the service commanders in each budgetary cycle.

---

\(^1\) All data in this section have been compiled from the open literature and represent British equipment assets in early 1988.

\(^2\) Publicly available MoD and Parliamentary data are used when possible; however, data limitations occasionally necessitate relying on unofficial sources and author's estimates. In this case, assumptions and sources are explicitly stated.


\(^5\) One major change to the policy established by the Nott review was the reduction from three to two ASW carrier groups and the eventual phase out of amphibious support ships. These decisions were reversed in the aftermath of the Falkland's conflict.

\(^6\) A formal defence review in the near future seems unlikely, given that reviews are politically unpopular and are viewed as tantamount to acknowledgement of defense management failure.
ARMY

Missions

Army missions include the British Army of the Rhine's (BOAR) role in NATO's Northern Army Group (NORTHAG), homeland defense, and out-of-area operations.

The central focus of the British Army remains its commitment7 to central Europe and the defense of its corps operations in NORTHAG. This includes anti-tank operations, air defense, and offensive support. For more than 30 years, the British have maintained a force of at least 55,000 troops in the FRG. The BOAR maintains three armoured division headquarters, seven armoured brigades, and one air-mobile brigade in peacetime; the total troop commitment to central Europe would increase to more than 150,000 in a conflict as forces from England reinforce those in Germany. Reinforcement includes an infantry battalion and supporting equipment available to NATO's Supreme Allied Commander for deployment on either the northern or southern flanks and the U.K. Mobile Force (UKMF) for deployment to the Baltic Approaches.

The recent expansion of the Territorial Army to a planned six infantry battalions would form much of the British Army's homeland defense. Territorial Army and Army reservists troops would be assigned to reinforce existing units. Finally, The Army would also support British operations in Northern Ireland, Gibraltar, Hong Kong,8 and the Falkland Islands.

Equipment

The Army has announced several significant modernization programs for the 1990s and early 2000s. The personnel-intensive nature of the Army limits the total spending on major equipment items. This short list is exacerbated by the Army's spending on relatively minor equipment items, such as rifles, trucks, small

8This commitment will terminate in 1997.
artillery, and the like. Major current and replacement equipment which support these missions, and replacement equipment cost, are shown in Table 1.
### Table 1
MAJOR BRITISH ARMY EQUIPMENT

<table>
<thead>
<tr>
<th>Current Equipment</th>
<th>Number</th>
<th>Average Age</th>
<th>Replacement Equipment</th>
<th>Number</th>
<th>IOC</th>
<th>Unit Cost</th>
<th>Total Cost</th>
<th>Costs, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helicopters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lynx, Gazelle</td>
<td>269</td>
<td>12</td>
<td>Light Attack Helicopter (LAH)</td>
<td>300c</td>
<td>1995</td>
<td>1.5d</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td><strong>ATGW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milan</td>
<td>NAc</td>
<td>12f</td>
<td>Trigat medium range (MR)</td>
<td>3000e</td>
<td>1995</td>
<td>NA</td>
<td>300h</td>
<td>300</td>
</tr>
<tr>
<td>Swingfire ATGW</td>
<td>NA</td>
<td>18</td>
<td>Trigat long range (LR)</td>
<td>3000</td>
<td>1997</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>SAMS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blowpipe/Javelin</td>
<td>NAc</td>
<td>9</td>
<td>Starstreak</td>
<td>NAe</td>
<td>1989</td>
<td>NAe</td>
<td>700j</td>
<td>500j</td>
</tr>
<tr>
<td>Rapier</td>
<td>120</td>
<td>17</td>
<td>Rapier 2000/B2</td>
<td>120</td>
<td>1992</td>
<td>NA</td>
<td>2000k</td>
<td>1850l</td>
</tr>
<tr>
<td><strong>Battle Tanks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Challenger</td>
<td>431d</td>
<td>3</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1.5</td>
<td>655</td>
<td>150m</td>
</tr>
<tr>
<td>Chieftain</td>
<td>500</td>
<td>16</td>
<td>Leopard 2, M1A1, Challenger 2</td>
<td>500</td>
<td>1992</td>
<td>2.5p</td>
<td>1250</td>
<td>1250</td>
</tr>
<tr>
<td><strong>AFVs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FV432 AFV</td>
<td>2400</td>
<td>20</td>
<td>Warrior/Saxon/FFLV</td>
<td>2400f</td>
<td>1988</td>
<td>1f</td>
<td>2400</td>
<td>1920f</td>
</tr>
<tr>
<td>Ferret AFV</td>
<td>1100</td>
<td>30</td>
<td>Warrior/Saxon/FFLV</td>
<td>1100</td>
<td>1998</td>
<td>1</td>
<td>1100</td>
<td>1100</td>
</tr>
<tr>
<td>Scorpion AFV</td>
<td>270</td>
<td>13</td>
<td>FFLAV</td>
<td>270</td>
<td>1997</td>
<td>1</td>
<td>270</td>
<td>270</td>
</tr>
<tr>
<td>Fox</td>
<td>200</td>
<td>13</td>
<td>FFLAV</td>
<td>200</td>
<td>1997</td>
<td>1</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Saxon</td>
<td>200</td>
<td>3</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Spartan</td>
<td>200</td>
<td>3</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Scimitar FV-107</td>
<td>300</td>
<td>2</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Artillery</td>
<td>Quantity</td>
<td>Status</td>
<td>System</td>
<td>Availability</td>
<td>Year</td>
<td>Cost</td>
<td>Total Cost</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>--------------</td>
<td>--------</td>
<td>--------------</td>
<td>------</td>
<td>------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>175 mm M107 artillery</td>
<td>36</td>
<td>unavailable</td>
<td>MLRS</td>
<td>unavailable</td>
<td>1990</td>
<td>NA</td>
<td>410</td>
<td>2451</td>
</tr>
<tr>
<td>105 mm artillery</td>
<td>220</td>
<td>unavailable</td>
<td>ADP Rtes</td>
<td>unavailable</td>
<td>1992</td>
<td>NA</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>155 mm howitzers</td>
<td>173</td>
<td>7s</td>
<td>undetermined</td>
<td>unavailable</td>
<td>1992</td>
<td>NA</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>£8685</strong></td>
<td></td>
</tr>
</tbody>
</table>


bSome numbers are rounded.
cIncludes some attrition buy for Alouette, Scout, Beaver currently in service.
dBased on Lynx AH.7 price of £1.5m. DMS, Market Intelligence Report, Author’s estimate of LAH is slightly higher than Lynx cost.
eUnavaiable.
fUpgraded in 1984.
gArbitrary division between MR and LR.
iDMS, Market Intelligence Reports and recent Statement on the Defence Estimates. The latter reports only initial production costs.
jAuthor’s estimate.
kIncludes RAF Rapier production costs.
lIncludes 17 training vehicles. Approximately 200 delivered thus far.
nDoes not include reserve units.
pThis represents an increase over Challenger production costs of £1.5m. Estimates based on DMS, Market Intelligence Reports, “Abrams ’made in UK’ offer to VSEL,” Jane’s Defence Weekly, June 18, 1988, p. 1195, and Mark Daly, “The threat facing the UK main battle tank industry,” Jane’s Defence Weekly, July 2, 1988, pp. 1764-5. Daly reports an M1A1 production unit cost proposal of £2.5m.
qAbout one-third of FV432 and Ferret will be replaced by Warrior and Saxon. The remainder will be replaced by FFLAV or other AFVs.
sBritish Army’s dilemma over ‘outdated’ howitzers,” Jane’s Defence Weekly, February 20, 1988, p. 289.
tIan Kemp, “UK stalls on ‘difficult decisions’,” Jane’s Defence Weekly, May 28, 1988, p. 1057. Kemp reports this will replace the abandoned SP70 program.
uBased on conversations with RAND staff.
A large share of future Army requirements centers around replacing many of the Army's armoured fighting vehicles (AFVs), many of which were produced in the 1950s. The FV432, which comprises the bulk of the Army AFV inventory, was produced between 1963 and 1971. Some near-term requirements for AFVs will be filled by recent Saxon and Warrior orders, but in the long term, the Army must replace older AFVs. A recent journal reports that the Army hopes to undertake an ambitious program to build as many as 5000 AFVs. This new class of AFVs, designated Future Families of Light Armoured Vehicles (FFLAV), will perform multiple roles. Figure 1 illustrates the projected composition of armoured fighting vehicles, excluding main battle tanks.

Fig. 1—Army armoured vehicles

---

9 About 1100 Ferret AFVs were produced between 1952 and 1971. Most of the older models have probably withdrawn from service; nevertheless, the average age is probably around 25 years. See Jane's Weapon Systems for age estimates.

The Trigat program should result in more capable anti-tank guided weapons to replace Milan and Swingfire. Milan systems were upgraded in 1984, although their capability against increasingly capable Soviet tanks in the 1990s and early 2000s is suspect. Trigat long-range (LR) weapons will also be capable of helicopter launch.

Lynx and Gazelle anti-tank helicopters will most likely be replaced in the late 1990s with the Light Attack Helicopter (LAH), although a TOW upgrade is due shortly. The MoD has not announced a follow-on replacement to Lynx and Gazelle, but it seems unlikely that either will continue to operate beyond the mid-to late-1990s. The Light Attack Helicopter (LAH) has not entered the development phase, although one would expect this in the next several years.

Army surface-to-air missile (SAM) modernization will continue with the introduction of the Rapier B2 and Rapier 2000 systems. Rapier B2 will enter service in the next few years, while the Rapier 2000 should become operational between 1992 and 1994. Army efforts to upgrade its air defense assets closely parallel RAF efforts. Starstreak, a hand-held system and the next step in Blowpipe and Javelin's continuing upgrades, has been funded since 1986 and should enter service in 1989.

Significant changes are also planned for main battle tanks. Figure 2 illustrates these changes.

---

11This retirement date corresponds with announced retirement rates of RAF Wessex and Puma at about 15 years. The dozen or so recently-delivered Lynx AH.7s should operate into the early 2000s.
The MoD is now studying several options for the replacement of its Chieftain tanks, including upgraded Challengers, the German-produced Leopard 2, and the U.S. M1A1.

Finally, the MoD plans to modernize its artillery inventory. The MLRS 1 (Multiple Launch Rocket System) should be operational in the early 1990s, replacing the 175 mm M107 gun. Other improvements include ADP Bates 155 mm artillery and possibly the Phoenix RPV in both the reconnaissance and attack roles.

ROYAL AIR FORCE

Missions

The RAF performs four broadly-defined major defense missions: air defense, maritime and ground strike and attack, transport, and helicopter support.\textsuperscript{12}

\textsuperscript{12}Transport missions include strategic and tactical airlift for all services, transport for the Royal Family, and various small types of aircraft for other VIP transport. Helicopter support
The RAF devotes a large share of its resources to homeland air defense and air defense in NATO's central region. The RAF utilizes a layered homeland air defense with Phantom and Tornado F.3 aircraft providing both long- and short-range coverage against attacking bombers and cruise missiles. Bloodhound surface-to-air missiles provide coverage at medium distances, while Rapier surface-to-air missiles provide short-range coverage.

The RAF also devotes a large portion of its assets to maritime and ground strike and attack missions. A majority of the tactical aircraft assets, including Tornado and Jaguar GR.1, Harrier GR.3 variants are assigned to the Second Allied Tactical Air Force (2 ATAF) in the FRG. Buccaneer S.2 aircraft perform maritime strike and attack missions.

A host of other RAF missions, including transport, strategic reconnaissance, and search and rescue are performed by various other aircraft in the RAF inventory.

**Equipment**

The composition of RAF aircraft and other major equipment assets will undergo several changes in the near future. Table 2 illustrates current and replacement air defense equipment, as well as their estimated replacement costs.

---

includes tactical support of Army and Royal Navy forces and search and rescue operations. The RAF also provides strategic reconnaissance and electronic counter-measure (ECM) capabilities although the assets for these missions are few.

13It would be more appropriate in a detailed description of RAF missions to break this category down into seven separate missions: air interdiction, offensive counter air, battlefield air interdiction, close support, tactical reconnaissance, maritime attack, and nuclear strike; however, in the interests of brevity, I have combined these categories.
The defense estimates indicate an approximate $5.5 million program (development and production) will cost an estimated $1.5 million. The production costs are estimated at $1.95 million. Recently, estimates of $4.5 million have been made in the context of the defense budget. A detailed analysis of these estimates is presented in the table below.

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td></td>
</tr>
<tr>
<td>10000</td>
<td></td>
</tr>
<tr>
<td>100000</td>
<td></td>
</tr>
<tr>
<td>1000000</td>
<td></td>
</tr>
</tbody>
</table>

The table above provides a breakdown of the estimated costs for various categories. The total cost is estimated at $5.5 million, with the production costs alone estimated at $1.95 million.
Figure 3 graphically illustrates the projected future composition of RAF air defense tactical aircraft to 2005.

![Graph showing projected composition of RAF air defense tactical aircraft from 1988 to 2005.](image)

**Fig. 3 — RAF air defense tactical aircraft**

Tornado F.3 and Phantom F-4 aircraft provide the mainstay of the current air defense tactical aircraft inventory, although Hawk aircraft equipped with AIM-9L Sidewinders also provide a modest increase in capabilities.¹⁴ Shackleton Airborne Early Warning (AEW) aircraft will be replaced beginning in 1991 by 7 Boeing E-3 AWACs. The introduction of remaining Tornado F.3 aircraft will result in a modest increase in air defense capabilities from 10 to 12 tactical aircraft squadrons.

In the late-1990s and early 2000s, the European Fighter Aircraft (EFA) is scheduled to replace all remaining Phantoms in the air defense role. The RAF plans to purchase 250 EFA aircraft, of which perhaps 150 will be devoted to the

---

¹⁴Hawk aircraft will probably begin to be retired at least by the early-to-mid-1990s, although they may be retired sooner since many feel they add only marginally to the U.K.'s air defense capability. Cost concerns may also lead to their early retirement.
air defense mission. This should be sufficient for 5 air defense squadrons. Additional tankers, perhaps Tristars, may replace remaining VC10s as they near 35 years average age. SAM improvements are also scheduled. These include a Rapier point defense upgrade and "M-SAM," a collaborative NATO project.

Table 3 lists current and replacement RAF strike and attack tactical aircraft assets and the costs of these replacement aircraft.

15As Table 2 notes, this is a somewhat arbitrary division of the total aircraft purchase.
## Table 3

### MAJOR RAF STRIKE AND ATTACK EQUIPMENT

<table>
<thead>
<tr>
<th>Current Equipment</th>
<th>Number (squadrons)</th>
<th>Average Age</th>
<th>Replacement Equipment</th>
<th>Number(squadrons)</th>
<th>IOC</th>
<th>Unit Production Cost</th>
<th>Total Cost</th>
<th>Costs, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tornado GR.1</td>
<td>9</td>
<td>4</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Buccaneer S.2</td>
<td>2</td>
<td>21</td>
<td>undetermined</td>
<td>2</td>
<td>1995</td>
<td>19.5</td>
<td>915</td>
<td>915</td>
</tr>
<tr>
<td>Nimrod MR.2</td>
<td>4</td>
<td>17</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Harrier GR.3</td>
<td>3</td>
<td>11P</td>
<td>Harrier GR.5</td>
<td>3</td>
<td>1988</td>
<td>13.5</td>
<td>1270</td>
<td>985</td>
</tr>
<tr>
<td>Jaguar GR.1, R.1</td>
<td>4</td>
<td>12</td>
<td>European Fighter Aircraft</td>
<td>2</td>
<td>1998</td>
<td>24</td>
<td>2400</td>
<td>2400</td>
</tr>
<tr>
<td>Attrition buys</td>
<td>NA</td>
<td>NA</td>
<td>Tornado GR.1</td>
<td>NA</td>
<td>1994</td>
<td>19.5</td>
<td>585</td>
<td>585</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>£4885</td>
</tr>
</tbody>
</table>

---


^1 Excludes OCUs unless otherwise indicated.

^2 Most age estimates derived from DMS, Market Intelligence Reports, Jane’s All the World’s Aircraft, and IISS, The Military Balance.

^3 Most age estimates derived from DMS, Market Intelligence Reports, Jane’s All the World’s Aircraft, and IISS, The Military Balance.

^4 Some numbers are rounded. See squadron numbers for aircraft in total cost calculations.

^5 Excludes Tactical Weapons Training and Tri-national Training Units. 220 aircraft.

^660 aircraft.

Based on conversations with RAND staff and estimated MoD outlay rate.

Assumes 150 of 250 EFA designated for air defense role and 25 aircraft per squadron. Excludes 1 OCU.

Assumes an initial production run of the EFA ground attack variant.


P71 aircraft.

Q10 aircraft.


S7 aircraft.

Includes Nimrod shut-down costs of approximately £100m, 7 E-3 aircraft.

Author's estimate.

V6 aircraft.

W9 aircraft.

The relatively high ages and flying hours indicate a possible replacement before 2005. Jane's All the World's Aircraft reports that these aircraft were produced between 1962 and 1964.

Y15 aircraft.

Z5 aircraft. Author's estimate.

bbModification costs of existing VC10s only.

cConversion of Nimrods may be converted to tankers, Jane's Defence Weekly, May 21, 1988, p. 1000.

dd10 aircraft. Author's estimate.

Modification costs of existing Nimrods only.

Purchase for the RAF in the Land procurement category. Follow-on to Hawk. 8 nations have agreed to a one year study. Nick Cook, "UK's Bloodhound successor: BAe in MSAM studies," Jane's Defence Weekly, March 26, 1988, p. 551.

Based on French and German shares of project. Total program costs estimated at £1.4b. DMS, Market Intelligence Reports. Alternatively designated the SA/SAN-90 or MFS-2000.

Purchased for the RAF in the Land procurement category.

Estimated £2000 million system cost.

Based on average aircraft loss rates. Assumes 5 aircraft purchased.
Figure 4 graphically illustrates strike and attack asset composition over about the next two decades.

![Graph showing the number of squadrons of different aircraft types from 1988 to 2005.]

Fig. 4—RAF strike and attack tactical aircraft

Currently, the RAF's ground attack mission is dominated by nine all-weather Tornado GR.1 squadrons, although Harrier and Jaguar squadrons provide a daytime ground attack capability for closer-range missions. The Tornado squadrons also perform nuclear strike missions with gravity weapons.¹⁶ Jaguar aircraft provide tactical reconnaissance, although in the future, Tornado aircraft will perform this mission.

Buccaneer aircraft provide maritime strike and attack capabilities, although the age of the Buccaneer fleet makes it unlikely that they will remain in service beyond the mid-1990s. Nimrod patrol aircraft support the Buccaneer mission and also aid in anti-submarine warfare (ASW) missions.

¹⁶Stand-off nuclear weapons delivered by Tornado are planned for future missions.
Modernization of ground strike and attack assets is nearly complete and few changes will occur in the near-term,\textsuperscript{17} although Harrier GR.5 aircraft will shortly replace current Harrier GR.3 aircraft.\textsuperscript{18} There are no current announced plans to replace Buccaneer aircraft, although there is speculation that this role will be carried on by the procurement of additional Tornado aircraft equipped with Sea Eagle anti-ship weapons. The RAF plans to replace Jaguar aircraft in the mid- to late-1990s with EFA. No replacement for Nimrod patrol aircraft is likely until well after the turn of the century.

Equipment requirements for RAF helicopter, strategic and tactical transport, strategic reconnaissance, and electronic counter-measure aircraft are significant, although the replacement costs for these are modest. Table 4 lists current and replacement equipment and the costs of these replacement equipment items.


\textsuperscript{18}Some GR.3 variants may remain in service into the 1990s, given their young ages. In the long run, the MoD may consider the Small Agile Battlefield Aircraft (SABA) or another VSTOL in the close air support role to replace Harrier GR.5s, although this will probably not occur before 2005. For an overview of SABA, see David A. Brown, "British Seek Risk-Sharing Partners for High-Agility Aircraft Project," Aviation Week and Space Technology, December 14, 1987, p. 61. Also see Milavnews NL-293/3/86, p. 14 and NL-300/10/86, p.15, NL-315/1/88, p. 13. Milavnews NL-297/7/86 p. 13 reports that the earliest IOC for a SABA type aircraft would be about 2005-2010, although earlier reports indicated a 2000 IOC. See AAS, Milavnews, Vol. 23 NL-268/2/84, p. 11.
### Table 4

**MAJOR RAF HELICOPTER, TRANSPORT, AND OTHER EQUIPMENT**

<table>
<thead>
<tr>
<th>Current Equipment</th>
<th>Number (squadrons)</th>
<th>Average Age</th>
<th>Replacement Equipment</th>
<th>Number(squadrons)</th>
<th>IOC</th>
<th>Unit Production Cost</th>
<th>Total Cost</th>
<th>Costs, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinook</td>
<td>3.5B</td>
<td>6</td>
<td>EH-101i</td>
<td>3.5i</td>
<td>1998</td>
<td>4.9i</td>
<td>280</td>
<td>280</td>
</tr>
<tr>
<td>Puma</td>
<td>3.1</td>
<td>15</td>
<td>EH-101m</td>
<td>3.1</td>
<td>1991</td>
<td>4.9</td>
<td>270</td>
<td>245n</td>
</tr>
<tr>
<td>Wessex</td>
<td>1.5p</td>
<td>15</td>
<td>EH-101</td>
<td>1.5q</td>
<td>1992</td>
<td>4.9</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Wessex SAR</td>
<td>1.5</td>
<td>15</td>
<td>EH-1101</td>
<td>1.5</td>
<td>1992</td>
<td>4.9</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Sea King SAR</td>
<td>1.5</td>
<td>6</td>
<td>EH-101PP-1</td>
<td>1.5</td>
<td>1998</td>
<td>4.9</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>VC10 transport</td>
<td>1.5</td>
<td>16w</td>
<td>VC10/Tristar/other</td>
<td>0.33x</td>
<td>1998</td>
<td>15.9</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>C-130 transport</td>
<td>1.5</td>
<td>20</td>
<td>undesignated</td>
<td>4.2</td>
<td>1995ab</td>
<td>20bb</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Canberra PR.1cc</td>
<td>1dd</td>
<td>29</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**Total Cost** £1,925

---


**b** Includes OCUs, excludes training squadrons unless otherwise indicated.

**c** Most age estimates derived from DMS, Market Intelligence Reports, *Jane's All the World's Aircraft*, and IISS, *The Military Balance*.

**d** Per aircraft. Some numbers are rounded.

**e** See squadron number for number of aircraft used in total cost calculations.

**f** Transport.
57 aircraft. Includes some out of area forces. For this reason, helicopter squadron numbers may not correspond with those in the most recent Statement on the Defence Estimates.

Speculative, although EH-101 procurement seems likely given previous orders.

World Air News, "Air Pictorial (June 1987), p. 210 estimates a £300 million package for 25 EH-101s, 16 Lynx (£1.75 million each), and 16 Sea Kings (£4.1 million), resulting in an approximate 4.9 million dollar EH-101 production unit cost. See DMS, Market Intelligence Report for Lynx and Sea King cost estimates. The eagerness to purchase EH-101 might result from a desire to lower program unit costs. Fixed EH-101 development costs are estimated at £450 million. A larger buy would decrease program unit costs. See AAS, Milavnews NL.302/12/86, p. 13.

Transport.

155 aircraft.


Assumes 10% of funds for these have been disbursed.

Includes some out of area forces. 41 aircraft.

18 aircraft.

Search and rescue.

218 aircraft.

Speculative, although seems likely given EH-101 replacement of RN Wessex SAR assets.

19 aircraft.


Does not include Tristars.

5 aircraft. Author's estimate based on VC10 age, conversations with RAND staff.

Tristar costs, according to recent Statement on the Defence Estimates.

245 aircraft.


Based on the current cost of similar aircraft.

Performs ECM as well as photo-reconnaissance.

1 aircraft.

Small aircraft, VIP transport, etc. Assumes no training aircraft required.

Author's estimate.
The RAF provides helicopter support for all armed services, including five search and rescue squadrons and nine logistical support squadrons.\textsuperscript{19} Wessex and Sea King helicopters perform search and rescue missions, while Chinook, Puma, and Wessex helicopters provide logistical support.

VC10 and Tristar aircraft provide strategic transport, while Hercules aircraft serve as tactical transport.\textsuperscript{20} Four squadrons of Canberra aircraft perform strategic reconnaissance and electronic counter-measures missions.

The RAF plans a modest modernization of helicopter, transport, and other equipment assets in the next several years. The RAF soon plans to replace Puma and Wessex tactical squadrons with EH-101 helicopters.\textsuperscript{21} However, there are no other specific plans for other aircraft in this category. Nevertheless, the RAF will likely replace Hercules and Canberra in the medium-term and perhaps Chinook, Sea King, and VC10 transport aircraft in the longer term.

\section*{ROYAL NAVY AND MARINES}

\subsection*{Missions}

The Royal Navy (RN) and Marines perform five missions: nuclear deterrence, anti-submarine warfare, surface escort and patrol, support of amphibious assault, and homeland protection, including minesweeping and patrol.

Since 1967 four Polaris SSBNs have performed the U.K.’s nuclear deterrence mission.\textsuperscript{22} Beginning in about 1994, the Royal Navy will slowly begin to replace Polaris with Trident SSBNs.\textsuperscript{23}

The Royal Navy has clearly begun to place a greater emphasis on its anti-submarine warfare mission and Britain’s role in the forward maritime strategy. Approximately twelve escort vessels and one ASW carrier, in addition to the RN’s

\textsuperscript{19}Some squadrons perform more than one mission which explains the discrepancy of this figure with Table 4 above. Total equipment assets would form about 10.5 squadrons.

\textsuperscript{20}As mentioned previously, other transport services include VIP and other personnel transport. However, they will not be examined in this paper.

\textsuperscript{21}Additional EH-101 helicopters may be necessary with the formation of a joint RAF-Army brigade.

\textsuperscript{22}Polaris SLBMs were upgraded with Chevaline in the early 1980s.

\textsuperscript{23}The first operational submarine is scheduled for 1994 with the remainder of the fleet entering service at the rate of one per year.
27 attack submarines, would participate in the forward deployed Anti-submarine Warfare Striking Force Atlantic. Other ASW forces, including Sea Harrier, Sea King, and Lynx aircraft would be utilized as needed.

The emphasis on the surface escort mission declined greatly following John Nott's 1981 Defence Review; however, the following year's Falklands conflict reopened the debate about the fleet's proper role and size. Currently, the RN has 52 frigates and destroyers, including those in retrofit.\textsuperscript{24} Although perhaps a dozen surface escort ships would be devoted solely to the ASW Striking Force Atlantic, others would patrol other critical areas including the southwest approaches and the English Channel area. Additional frigates are designated for the Royal Fleet Auxiliary at Argus. In total, however, perhaps 30 frigates and destroyers would serve to keep critical sea lanes open.

The Royal Navy and Marines also provide protection for and deployment of the joint U.K./Dutch amphibious force to reinforce NATO's northern flank, the Baltic Approaches, or the Atlantic Islands.\textsuperscript{25} Major equipment assets which participate directly in this mission include two amphibious assault ships (or landing platform docks, LPDs), about seven escort frigates, and one ASW carrier.

Finally, the Royal Navy performs several homeland missions, including mine countermeasures (MCM)\textsuperscript{26} defensive mining, search and rescue, and patrol missions. The RN currently maintains about 42 mine countermeasure vessels and 36 patrol vessels.\textsuperscript{27} The RN operates about a dozen other support ships.

**Equipment**

The Royal Navy and Marines requirements for major vessels and aircraft over the next two decades are significant. Tables 5 and 6 list major Royal Navy and Royal Marine combatants and Fleet Air Arm assets, respectively. They also estimate retirement dates, replacement equipment, and replacement equipment costs.

\textsuperscript{24}Excluding retrofit, the total is 45, according to the *Statement on the Defence Estimates*. 1988.

\textsuperscript{25}The force would in all likelihood be deployed to Norway.

\textsuperscript{26}Of course, mine countermeasures are not limited to home waters, as the RN presence in the Persian Gulf demonstrates; however, the focus of MCM would be in home waters.

\textsuperscript{27}Including retrofits.
Table 5
MAJOR ROYAL NAVY COMBATANTS*

<table>
<thead>
<tr>
<th>Current Equipment</th>
<th>Number</th>
<th>Average Age</th>
<th>Replacement Equipment</th>
<th>Number</th>
<th>IOC</th>
<th>Unit Cost</th>
<th>Total Cost(b)</th>
<th>Costs, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Submarines</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polaris SSBNs</td>
<td>4</td>
<td>19</td>
<td>Trident</td>
<td>4</td>
<td>1994</td>
<td>2315</td>
<td>9265</td>
<td>7100(c)</td>
</tr>
<tr>
<td>Trafalgar, Swiftsure, Valiant, Churchill, class SSNs</td>
<td>16(d)</td>
<td>11</td>
<td>Trafalgar</td>
<td>3(e)</td>
<td>1988</td>
<td>230</td>
<td>690</td>
<td>575(f)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SSN 20</td>
<td>10</td>
<td>1998(g)</td>
<td>230(h)</td>
<td>2300</td>
<td></td>
</tr>
<tr>
<td>Oberon class SSKs</td>
<td>11</td>
<td>17</td>
<td>Upholder</td>
<td>9(i)</td>
<td>1988</td>
<td>124</td>
<td>1118</td>
<td>870(j)</td>
</tr>
<tr>
<td><strong>Surface Ships</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASW carriers</td>
<td>3</td>
<td>4</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fearless, Intrepid assault ships</td>
<td>2</td>
<td>22</td>
<td>Undesignated(k)</td>
<td>2</td>
<td>1995</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Type 42, 82 class destroyers</td>
<td>13(l)</td>
<td>8</td>
<td>NFR-90(m)</td>
<td>12</td>
<td>1997</td>
<td>150(n)</td>
<td>1800</td>
<td>1800</td>
</tr>
<tr>
<td>Type 12, 21, 22 class frigates</td>
<td>39(p)</td>
<td>14</td>
<td>Type 23</td>
<td>20(q)</td>
<td>1989</td>
<td>96</td>
<td>1922</td>
<td>1730(f)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Type 22</td>
<td>3(r)</td>
<td>1989</td>
<td>150</td>
<td>450</td>
<td>225(s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ASW frigate</td>
<td>10</td>
<td>2002</td>
<td>150(t)</td>
<td>1500</td>
<td>1500</td>
</tr>
<tr>
<td>Support ships</td>
<td>NA</td>
<td>NA</td>
<td>Auxiliary oilers</td>
<td>6(w)</td>
<td>1993</td>
<td>115(x)</td>
<td>690</td>
<td>690</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Aviation support</td>
<td>1-2</td>
<td>1993</td>
<td>68</td>
<td>135</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Miscellaneous support, patrol</td>
<td>20(y)</td>
<td>1990(s)</td>
<td>10</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>MCMVs</td>
<td>42(z)</td>
<td>6</td>
<td>MCMVs</td>
<td>16(y)</td>
<td>1991</td>
<td>30</td>
<td>480</td>
<td>450</td>
</tr>
</tbody>
</table>

Total Costs £17,775
Current and replacement equipment, as well as cost estimates unless otherwise specified are based on Paul Beaver, *Encyclopaedia of the Modern Royal Navy* (Annapolis: Naval Institute Press), 1982 and annual *Statements on the Defence Estimates*, unless otherwise indicated.

Some estimates are rounded.


One or two Swiftsure, as well as the 4 Trafalgar SSNs currently in service will remain in operation to 2005; thus, the additional 3 Trafalgar and 10 SSN-20 boats cited here will increase the total number of SSNs in service as described in the text.

One is currently on order and should enter service in late 1988.

Assumes less than 15% of Trafalgar costs on 3 boats has been disbursed.

Assumes a lag in deliveries of SSNs after Trafalgar deliveries in order to accommodate Trident production.

Production costs estimated equal to Trafalgar.

Four are currently on order. One will be delivered in 1988-89. As indicated in the text, the total number of SSKs will likely decline between 1988 and 2005.

Assumes 50% of costs of four on order falls after 1988.

I have arbitrarily assumed that these will be replaced at a cost of £200.

Many of these will remain in service to 2005.

The U.K. recently formally joined the NFR-90 project. "NFR-90 agreement releases new funds," *Jane's Defence Weekly*, May 14, 1988, p. 929. The NFR-90 is primarily designed as an anti-air warfare ship.


Includes 13 Type 22, 6 Type 21, 18 Leander, 1 Rothesay class, and one navigation training ship. The latter is engaged primarily in training exercises.

Based on Ralph Dunn, "RN planning for 20 Type 23 frigates," *Jane's Defence Weekly*, September 5, 1987, p. 413. The MoD later denied it planned an order of this size; however, approximately 33 new frigates, shown here as 3 Type 22, 20 Type 23, and 10 ASW frigates are required to maintain current force structure. 4 Type 23s are on order.

Assumes 50% of 4 Type 23 frigates on order funds are dispersed prior to 1989.

One on order currently.

Assumes 50% of Type 22 funds dispersed after 1988.

Assumed to equal NFR.90 cost.

The replacement equipment in this category does not always directly replace current RN assets.

Number based on conversations with RAND staff.


Author's estimate for total number and costs.

15% Class MCMVs are likely to be replaced before 2005. Other MCMVs are relatively new and few will be replaced before 2005.
Table 6
MAJOR FLEET AIR ARM ASSETS

<table>
<thead>
<tr>
<th>Current Equipment</th>
<th>Number (squadrons)(^b)</th>
<th>Average Age</th>
<th>Replacement Equipment</th>
<th>Number (squadrons)</th>
<th>IOC</th>
<th>Unit Cost</th>
<th>Total Cost</th>
<th>Costs, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Harrier FRS.1</td>
<td>3</td>
<td>10</td>
<td>None(^c)</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Sea King HAS 5(^d)</td>
<td>7</td>
<td>5</td>
<td>EH-101/other</td>
<td>7</td>
<td>1998</td>
<td>4.9</td>
<td>345</td>
<td>345</td>
</tr>
<tr>
<td>Lynx HAS.2/3</td>
<td>3</td>
<td>17</td>
<td>EH-101</td>
<td>3</td>
<td>1991(^e)</td>
<td>4.9</td>
<td>147</td>
<td>110(^f)</td>
</tr>
<tr>
<td>Sea King AEW.2</td>
<td>1</td>
<td>5</td>
<td>EH-101/other</td>
<td>1</td>
<td>1998</td>
<td>4.9</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Sea King H.C.4</td>
<td>3</td>
<td>5</td>
<td>EH-101/other</td>
<td>3</td>
<td>1998</td>
<td>4.9</td>
<td>145</td>
<td>145</td>
</tr>
<tr>
<td>Sea King Mk.4/5(^g)</td>
<td>2</td>
<td>5</td>
<td>EH-101/other</td>
<td>2</td>
<td>1998</td>
<td>4.9</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Miscellaneous support</td>
<td>2(^h)</td>
<td>NA</td>
<td>NA</td>
<td>2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>100(^i)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total £850</td>
<td></td>
</tr>
</tbody>
</table>


\(^f\)Assumes 25% of costs disbursed prior to 1989.

\(^g\)Wessex HU.5 in this search-and-rescue role have recently been retired. "World Air News," *Air Pictorial*, p. 164.

\(^h\)Including 2 training squadrons and other miscellaneous support.

\(^i\)Author's estimate.
Submarines

A majority of the Royal Navy’s submarine equipment must be replaced before 2005. Much of the expense for replacement submarine equipment is due to the introduction of Trident SSBNs; however, significant expenditure will result as SSN and SSK fleets are modernized. Figure 5 illustrates the projected future composition of Royal Navy attack submarine assets.

![Submarine Diagram]

Fig. 5 — Royal Navy attack submarine assets

Trafalgar and Upholder class submarines will continue to replace older attack submarines. In order to maintain the current SSN force, the MoD should

---

28 Figure 1 is notional. I have tried to maintain a top-line of approximately 27 SSNs and SSKs through 2005. Vessels are retired near, but not exactly at their retirement age (25) in order to maintain this constant top-line count except in the mid- to late-1990s when Trident production will crowd out SSN production. Figure 1 considers SSNs and SSKs currently on order in determining top-line numbers for the next three to four years.

29 SSN and SSK retirement is assumed to occur at a maximum of 25 years. Thus, in (approximately) 1993, Trafalgar SSNs should have replaced the two remaining Valiant class SSNs.
order three SSNs every five years. The Thatcher government has essentially maintained this rate, ordering five Trafalgar class SSNs since 1979.

However, the MoD has explicitly expressed a desire to increase the ratio of nuclear to diesel attack submarines. A slightly higher SSN procurement rate is reflected in Figure 5, and as Table 5 indicates, the RN must order an additional 12 Trafalgar or SSN-90 vessels over the next 17 years to maintain current force levels.

Upholder class SSKs will likely continue to replace the aging Oberon class SSKs. In order to maintain aggregate attack submarine levels, albeit with a higher ratio of SSNs to SSKs, the RN should order an additional five SSKs in the next 17 years. Table 5 assumes this lower procurement rate for SSKs.

In short, under the assumptions outlined, the RN must add 17 attack submarines, in addition to the five currently on order, to maintain fleet size.

Surface Combatants

Requirements for Royal Navy major surface combatants are also significant. Figure 6 illustrates the projected future composition of major Royal Navy surface combatants.

By 1998, Trafalgar should have replaced the three Churchill class SSNs, and by 2005, Trafalgar or a suitable follow-on (SSN-90) should have replaced the six Swiftsure SSNs.

30This is calculated by the size of the fleet divided by the average retirement age. In this case, 15/25 = .6. This is obviously valid over the long-run, although in the short-run, this may not maintain the fleet size if a large percentage of vessels are soon nearing retirement age. Lead production time for SSNs is about 6 years. See House of Commons Defence Committee, *Defence Commitments and Resources and The Defence Estimates 1986-86* HC 37-II (London: HMSO), p. 114.


32As noted in Table 5, this does not include the 4 Trafalgar SSNs in service (by the end of 1988) or the 1 on order.

33This is in addition to the four Upholder class SSKs currently on order.
John Nott's 1981 *Defense Review* stated a goal of maintaining "about 50" frigates and destroyers, and this goal has been repeated, most recently in the *Statement on the Defence Estimates 1988*. Approximately three new frigates are needed each year to maintain the current fleet size.

Type 23 and Type 22 ships will continue to replace aging Type 12 and 21 frigates in the anti-submarine warfare role. In the longer-term, the NFR-90, a jointly developed and produced NATO frigate, should replace Type 42 class.

---

34I have used alternative ship designations to limit confusion about differing designations for British frigates. The NFR-90 is the NATO frigate, Type 23s represent Duke or Norfolk class, Type 42 Birmingham, Type 12 Leander, Type 22 Broadsworth, and Type 21 Amazon, Bristol class (Type 82) vessels are included in Type 42 total.


36This assumes no retrofits on newer ships and a lifetime of 18 years. Although the RN’s stated policy is to minimize the number of mid-life retrofits, a significant number of retrofits were underway in 1987. (14% of the frigate and destroyer fleet was undergoing retrofit or on stand-by for retrofit.) In comparison, 22, 17, and 7% of the fleet were undergoing retrofit in 1970, 1975, and 1983, respectively. Thus, some ships will probably undergo retrofit, while others will not, and the average retirement age will fall between 18 and 25 years. If we assume (somewhat arbitrarily) that the average retirement age is 21.5 years, we conclude that, as a rule of thumb, about 2.5 ships should be ordered each year to maintain the current fleet of 52 frigates and destroyers.
destroyers in the anti-air role. The NFR-90 project should lead to the purchase of at least a dozen new ships.\textsuperscript{37}

In sum, 45 of the existing 52 frigates and destroyers must be replaced before 2005 to maintain current strength.\textsuperscript{38} However, the MoD has not maintained this rate, ordering a total of 8 Type 22 and 4 Type 23 frigates since 1979, an average of about 1.5 per year.\textsuperscript{39} Seven Type 22s have been delivered; while no Type 23s have been delivered. At this acquisition rate, the fleet will fall to about 42 in 2005, a 22 percent decrease in the inventory.

The RN has not yet determined whether it will maintain or seek replacements for its two amphibious assault ships (landing platform docks, LPDs) beyond 1995. However, given the importance of the LPDs in Royal Marine operations, failure to replace them seems unlikely. The RN also seems likely to purchase two aviation support ships.\textsuperscript{40} This is reflected in Table 5.

The three ASW carriers are relatively new and should not be replaced until around 2010-2015, assuming that their lifetime is about 35 years. The oldest ASW carrier, the Invincible, was constructed in 1980.

Modernization of MCMV assets should continue, although there are conflicting reports about future MCM force size.\textsuperscript{41} Most new MCMV assets will replace the Ton class.

\textsuperscript{37}See Peter Riddell, "UK to join warship project," \textit{Financial Times}, January 20, 1988, p. 1. In fact, an order for only 12 NFR-90 ships is insufficient to maintain the fleet size. Instead, the fleet would decrease to a total of about 44 in 2005. This, of course, depends on frigate orders, although the number of destroyers will fall unless more than 12 NFR-90 ships are ordered.

\textsuperscript{38}This total includes 1 Type 22 and 4 Type 23s currently on order. An additional 40 must be ordered to maintain fleet size. If we arbitrarily extend the retirement age by 5 years, the RN must still replace 38 (i.e., order 33 more) frigates and destroyers by 2005.

\textsuperscript{39}Secretary of State for Defence George Younger recently announced plans for an order of "up to four" additional Type 23 frigates. Ian Curtis, "Britain's Conservative Conference: Next Trident to Vickers; More Type 23s," \textit{Defense and Foreign Affairs Daily} October 9, 1987, p. 2; House of Commons Defence Committee, \textit{Defence Commitments and Resources and The Defence Estimates 1986-86} HC 37-II (London: HMSO), HC37-II, p. 13. An additional 16 may be ordered. See Ralph Dunn, "RN planning for 20 Type 23 frigates," \textit{Jane's Defence Weekly}, Sept. 5, 1987, p. 413. However, the MoD recently stated that it does not intend to order the necessary 3 per year.

\textsuperscript{40}Based on conversations with RAND staff. These will replace the Hermes.

\textsuperscript{41}See Desmond Wettern, "RN to lose support ship in MCM force cuts," \textit{Jane's Defence Weekly}, August 29, 1987, p. 368. Wettern reports that RN's only MCMV support ship will be retired this year and not replaced. A 1980 plan called for a 15 year purchase of as many as 60 MCMVs.
Fleet Air Arm Assets

The Sea Harrier will also likely be replaced as it nears the 20 year average age mark, although the MoD has not announced a replacement. Given the age distribution of Sea Harriers, some will almost certainly be replaced before 2005.\textsuperscript{42} The RN/M currently operates 16 active helicopter squadrons.\textsuperscript{43} EH-101 squadrons will replace Wasp\textsuperscript{44}, Lynx, Wessex, and some Sea King units in the near-term. In the long term, EH-101 or a similar type aircraft will replace remaining Sea King and Wessex aircraft.

TOTAL REQUIREMENTS AND THE EFFECTS OF EQUIPMENT COST GROWTH

Table 7 illustrates the total financial requirements of modernizing major equipment outlined earlier in this section.

\textsuperscript{42}Defense and Economy World Report, No. 1036, March 2, 1987, p. 5813 estimates a late 1990s Sea Harrier replacement.

\textsuperscript{43}This does not include training units.

\textsuperscript{44}By late 1988, most Wasp squadrons will have been retired.
Table 7
MODERNIZATION COSTS OF MAJOR EQUIPMENT

(millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF air defense equipment</td>
<td>7,925</td>
</tr>
<tr>
<td>RAF strike and attack equipment</td>
<td>4,885</td>
</tr>
<tr>
<td>RAF helicopter, transport equipment</td>
<td>1,925</td>
</tr>
<tr>
<td>Army equipment</td>
<td>8,685</td>
</tr>
<tr>
<td>Royal Navy submarines</td>
<td>10,845</td>
</tr>
<tr>
<td>Royal Navy surface ships</td>
<td>6,930</td>
</tr>
<tr>
<td>Royal Navy Fleet Air Arm assets</td>
<td>850</td>
</tr>
<tr>
<td>Total Costs</td>
<td>£42,045</td>
</tr>
</tbody>
</table>

As Table 7 demonstrates, the total production costs of equipment modernization is slightly more than £42 billion. However, as noted previously, these cost estimates are based upon current MoD or other source estimates. As in the German case study, this undoubtedly understates the financial requirements since cost growth, particularly for systems which have not yet reached the production stage, is common. In short, cost growth for many of the systems outlined above may be significant.

The German case study indicated significant cost growth in the production of the Tornado fighter/attack aircraft. Studies in the U.K. also point toward the likelihood of major system production cost growth. Several sources indicate major equipment cost growth of 7-8% per year.\(^5\) In particular, a recent House of Commons report estimated production cost growth on several major weapons

---

systems of 29% over five years, or an annual rate of just over 5%. The report is particularly noteworthy since it estimated that perhaps one-half of the U.K. equipment budget eventually is consumed by unexpected cost growth.

As in the German case study, a range of feasible production cost growth, 0 to 7%, has been used to estimate future costs. Tables 8, 9, and 10 illustrate the effects of these cost growth rates on Army, RAF, and RN major system replacement costs. Each table assumes annual production cost growth of 0% to 7% compounded from 1988 to expected system IOC. Thus, systems already in production or slated for delivery in 1988 are assumed to have no cost growth. For various reasons, some other systems, such as Trident, are assumed to experience no or little cost growth despite their IOC date in the 1990s. The tables explicitly state these assumptions.

46“50% of UK budget going on excess costs,” Jane’s Defence Weekly, March 19, 1988, p. 493.

47This is truly staggering since it represents, in essence, 100% average system (i.e., development and production ) cost growth.
### Table 8

**EFFECTS OF PRODUCTION COST GROWTH: ARMY EQUIPMENT**

(in millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>IOC</th>
<th>Current Estimate</th>
<th>3.5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Attack Helicopter</td>
<td>1995</td>
<td>450</td>
<td>575</td>
<td>725</td>
</tr>
<tr>
<td>Trige *</td>
<td>1996</td>
<td>300</td>
<td>395</td>
<td>515</td>
</tr>
<tr>
<td>Starstreak</td>
<td>1989</td>
<td>500</td>
<td>520</td>
<td>535</td>
</tr>
<tr>
<td>Rapier 2000/B2b</td>
<td>1992</td>
<td>1850</td>
<td>2125</td>
<td>2425</td>
</tr>
<tr>
<td>Artillery c</td>
<td>1991d</td>
<td>695</td>
<td>770</td>
<td>850</td>
</tr>
<tr>
<td>Leopard 2, M1A1,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Challenger 2</td>
<td>1992</td>
<td>1400e</td>
<td>1585f</td>
<td>1835</td>
</tr>
<tr>
<td>Warrior/Saxon/FFLAV8</td>
<td>1988</td>
<td>1920</td>
<td>1920</td>
<td>1920</td>
</tr>
<tr>
<td>Warrior/Saxon/FFLAV9</td>
<td>1998</td>
<td>1100</td>
<td>1550</td>
<td>2165</td>
</tr>
<tr>
<td>FFLAVi</td>
<td>1997</td>
<td>270</td>
<td>370</td>
<td>500</td>
</tr>
<tr>
<td>FFLAVj</td>
<td>1997</td>
<td>200</td>
<td>275</td>
<td>370</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>£8,685</strong></td>
<td><strong>£10,085</strong></td>
<td><strong>£11,840</strong></td>
</tr>
</tbody>
</table>

*a*Includes both systems. Calculated using 1996 IOC.

*b*Includes RAF Rapier production costs.

*c*Includes MLRS, ADP Bates, and 155 mm howitzer replacements.

*d*Weighted average.

*e*Includes some residual payment on current order of Challengers as outlined previously in Table 1.

*f*Cost growth excluded from current Challenger order.

*g*Current production run to replace FV432.

*h*Later production run to replace Ferret.

*i*Production run replacing Scorpion.

*j*Production run replacing Fox.
Table 9
EFFECTS OF PRODUCTION COST GROWTH: RAF EQUIPMENT
(in millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>IOC</th>
<th>Current Estimate</th>
<th>3.5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air defense</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tornado F.3</td>
<td>1989</td>
<td>750</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>EFA</td>
<td>2000</td>
<td>3600</td>
<td>5440</td>
<td>8110</td>
</tr>
<tr>
<td>E-3 AWACS</td>
<td>1991</td>
<td>790</td>
<td>790</td>
<td>790</td>
</tr>
<tr>
<td>VC10 K.2</td>
<td>1988</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Nimrod K.2</td>
<td>1989</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>M-SAM</td>
<td>1995</td>
<td>1065</td>
<td>1355</td>
<td>1710</td>
</tr>
<tr>
<td>Rapier 2000</td>
<td>1993</td>
<td>1520</td>
<td>1935</td>
<td>2130</td>
</tr>
<tr>
<td>Tornado F.3</td>
<td>1994</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Strike/attack</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EFA</td>
<td>1998</td>
<td>2400</td>
<td>3385</td>
<td>4720</td>
</tr>
<tr>
<td>Buccaneer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>replacement</td>
<td>1995</td>
<td>915</td>
<td>915</td>
<td>915</td>
</tr>
<tr>
<td>Harrier GR.5</td>
<td>1988</td>
<td>985</td>
<td>1055</td>
<td>1130</td>
</tr>
<tr>
<td>Tornado GR.1</td>
<td>1994</td>
<td>585</td>
<td>585</td>
<td>585</td>
</tr>
<tr>
<td>Helicopter, Transport, and Other Assets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH-101/PP-1</td>
<td>1998</td>
<td>280</td>
<td>395</td>
<td>550</td>
</tr>
<tr>
<td>EH-101</td>
<td>1991</td>
<td>245</td>
<td>270</td>
<td>300</td>
</tr>
<tr>
<td>EH-101</td>
<td>1992</td>
<td>200</td>
<td>230</td>
<td>260</td>
</tr>
<tr>
<td>EH-101</td>
<td>1992</td>
<td>90</td>
<td>105</td>
<td>120</td>
</tr>
<tr>
<td>EH-101</td>
<td>1998</td>
<td>95</td>
<td>135</td>
<td>185</td>
</tr>
<tr>
<td>VC10/Tristar/other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transport</td>
<td>1998</td>
<td>75</td>
<td>105</td>
<td>150</td>
</tr>
<tr>
<td>C-130 replacement</td>
<td>1995</td>
<td>900</td>
<td>1145</td>
<td>1445</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>transport</td>
<td>NA</td>
<td>100</td>
<td>135</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>£14,795</td>
<td>£18,930</td>
<td>£24,235</td>
</tr>
</tbody>
</table>

*aReplacing Phantom. Assumes no further cost growth.
*bFigures exclude Nimrod shut-down costs. No cost growth due fixed agreement.
*cReplacing Victor aircraft. Assumes no cost growth due modification only.
*dAssumes no cost growth due modification only.
*ePurchased for the RAF in the Land procurement category.
*fAttrition purchase. Assumes no cost growth.
*gAssumes no cost growth since likely replacement (Tornado) in production.
*hReplacing Chinook.
*iReplacing Puma transport.
+jReplacing Wessex transport.
+kReplacing Wessex SAR.
|mCosts based on 1997 average IOC.
Table 10
EFFECTS OF PRODUCTION COST GROWTH: ROYAL NAVY EQUIPMENT

(in millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>IOC</th>
<th>Current estimate</th>
<th>3.5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet Air Arm</td>
<td>1997a</td>
<td>850</td>
<td>1160</td>
<td>1565</td>
</tr>
<tr>
<td>Trident</td>
<td>1994</td>
<td>7100</td>
<td>7855b</td>
<td>8750</td>
</tr>
<tr>
<td>Trafalgar SSN</td>
<td>1988</td>
<td>575</td>
<td>575c</td>
<td>575</td>
</tr>
<tr>
<td>SSN 20</td>
<td>1998</td>
<td>2300</td>
<td>3245</td>
<td>4525</td>
</tr>
<tr>
<td>Oberon SSKs</td>
<td>1988</td>
<td>870</td>
<td>870c</td>
<td>870</td>
</tr>
<tr>
<td>Assault ships</td>
<td>1995</td>
<td>200</td>
<td>255</td>
<td>320</td>
</tr>
<tr>
<td>NFR-90</td>
<td>1997</td>
<td>1800</td>
<td>2455</td>
<td>3310</td>
</tr>
<tr>
<td>Type 23 frigate</td>
<td>1989</td>
<td>1730</td>
<td>1790</td>
<td>1850</td>
</tr>
<tr>
<td>Type 22 frigate</td>
<td>1989</td>
<td>225</td>
<td>230</td>
<td>240</td>
</tr>
<tr>
<td>ASW frigate</td>
<td>2002</td>
<td>1500</td>
<td>2430</td>
<td>3870</td>
</tr>
<tr>
<td>Auxiliary oilers</td>
<td>1993</td>
<td>690</td>
<td>820</td>
<td>970</td>
</tr>
<tr>
<td>Aviation support</td>
<td>1993</td>
<td>135</td>
<td>160</td>
<td>190</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>support, patrol</td>
<td>1997d</td>
<td>200</td>
<td>275</td>
<td>370</td>
</tr>
<tr>
<td>MCMVs</td>
<td>1991</td>
<td>450</td>
<td>500</td>
<td>550</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>£18,625</strong></td>
<td><strong>£22,620</strong></td>
<td><strong>£27,955</strong></td>
</tr>
</tbody>
</table>

*aWeighted average of replacement equipment.

*bBoth categories assume no cost growth on Trident outlays in the U.S. Cost growth only on remaining uncommitted Trident outlays in the U.K. These uncommitted outlays are estimated at £3300 million.

*cNo cost growth since already in production.

*dAuthor’s estimate of average IOC.

Table 11 lists total costs of major replacement equipment for the Army, Royal Air Force, and Royal Navy and Marines under three cost growth scenarios. It indicates a range of major equipment funding requirement from £42 billion to slightly more than £64 billion.

*48Note that these aggregate cost growth estimates are in the 20-50% range, as found in previous work at RAND.
Table 11
EFFECTS OF COST GROWTH: ALL MAJOR EQUIPMENT

(£1987 million)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>0%</th>
<th>3.5%</th>
<th>7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAF air defense equipment</td>
<td>7,925</td>
<td>10,470</td>
<td>13,690</td>
</tr>
<tr>
<td>RAF strike and attack equipment</td>
<td>4885</td>
<td>5940</td>
<td>7350</td>
</tr>
<tr>
<td>RAF helicopter, transport equipment</td>
<td>1925</td>
<td>2520</td>
<td>3195</td>
</tr>
<tr>
<td>Army equipment</td>
<td>8685</td>
<td>10,085</td>
<td>11,840</td>
</tr>
<tr>
<td>Royal Navy submarines</td>
<td>10,845</td>
<td>12,545</td>
<td>14,720</td>
</tr>
<tr>
<td>Royal Navy surface ships</td>
<td>6,930</td>
<td>8915</td>
<td>11,670</td>
</tr>
<tr>
<td>Royal Navy Fleet Air Arm assets</td>
<td>850</td>
<td>1160</td>
<td>1565</td>
</tr>
<tr>
<td>Total Costs</td>
<td>£42,045</td>
<td>£51,635</td>
<td>£64,030</td>
</tr>
</tbody>
</table>

In summary, the equipment modernization costs for U.K. armed forces are estimated at about £42 billion. However, this does not include unanticipated cost growth, which studies typically indicate in the production of military equipment. Annual cost growth of 3.5% and 7.0% leads to significantly higher estimates of £52 and £64 billion, respectively. About 40% of these totals result from Royal Navy modernization requirements.
II. FORECASTING U.K. DEFENSE SPENDING

It is clear that British forces will require significant force modernization over the next 17 years in order to maintain current capabilities. To determine whether the MoD will have the available resources, forecasting aggregate defense budget growth is necessary.

Aggregate defense spending levels are perhaps more difficult to forecast in the short-than in the long-term. For example, a forecast of the U.S. defense budget in 1983 would probably not have been able to predict the sharp drop we are now experiencing. However, an analysis of historical data, such as the defense budget's share of GNP or the defense budget's share of the overall national budget, along with assumptions about future general budget growth and other factors, permit a more accurate forecast about average spending over the long term.

This section forecasts a range of U.K. defense spending to 2005. It assumes no major change in threat perception and uses two broad approaches. The first analyzes the defense budget's share of Gross Domestic Product (GDP), constant defense spending over time, and the defense budget's share of total government expenditures, to forecast a range of future defense spending levels. The second analyzes demographic and other budgetary and economic data to forecast likely growth in other areas of the national budget which compete with the MoD for funds. This may provide some insight into possible "crowding out" of the defense share of the national budget.

49See Todd Sandler and James C. Murdoch, "Defense Burdens and Prospects for the Northern Allies," in David B.H. Denoon, Constraints on Strategy: The Economics of Western Security (New York: Pergamon-Brassey's), 1986, pp. 59-113 and Bruce Don, Allies and Adversaries: Policy Insights Into Strategic Defense Relationships P-7242, The RAND Corporation, 1986 for more detailed budget forecasting methodology. The former uses Soviet defense spending, for example, as a surrogate for the "threat" variable. One can argue that uncertainty in measuring Soviet defense spending, and accordingly, the "threat" may diminish the validity of this model.
HISTORICAL MODELS

Defense’s Share of GDP

Figure 7 illustrates U.K. defense spending’s share of GDP from 1955 to 1990.\textsuperscript{50}

![Graph showing defense spending as a share of GDP.]

Fig. 7—Defense spending as a share of GDP

It illustrates the rather steady decline in the U.K. defense budget’s share of GDP. For example, the defense budget’s share of GDP fell from a high of just under 8% in 1955 to current levels of about 4.5%. It is projected to fall further in the next three years to approximately 4.2%, just slightly above mid- to late-1970s levels.\textsuperscript{51}

\textsuperscript{50}The data in Figure 8 is based on U.S. DoD data and may not directly correspond with U.K. Ministry of Defence (MoD) or Ministry of Treasury (MoT) data. For example, MoD statistics show a consistently higher defense share of GDP by about .5%. The U.S. data likely excludes some defense-related spending categories. The longer trend, however, is certainly valid. 1987-1990 data points are estimates and are based on recent MoT data. See The Government’s Expenditure plans 1988-89 to 1990-91, Cmd. 288-I, (London: HMSO, 1988), especially pages 30-33.

\textsuperscript{51}The lowest share was recorded in 1979 at 3.5%; the Thatcher build-up reached a high of 5.0% in 1984.
However, a fairly constant share of GDP seems to have been devoted to defense since 1970.\textsuperscript{52} The average share of GDP devoted to defense between 1970 and 1980 was 4.0%, while the average in the 1980s is forecast at 4.6%. The 1970-1990 average is 4.2%. Thus, British defense spending's share of GDP in a future high expenditure scenario may remain at this relatively constant share of GDP.

Long-term macroeconomic growth (and hence defense budget expenditure growth) may be forecast using either historical data or simple macroeconomic models. For example, the yearly GDP growth rate from 1955-1987 was 2.4%, although the rate from 1965-1987 fell to 2.2%, and the rate from 1975-1987 was just 2.0%. The growth rate from 1980-87 is slightly higher at 2.3%. A recent RAND study estimated long-term economic growth based on changes in capital, labor, and technology at 1.7% per year.\textsuperscript{53}

Thus, about 2%\textsuperscript{54} represents high case macroeconomic and defense budget growth rates from 1988 to 2005. This optimistic growth rate results in predicted average defense expenditures of £20.5 billion and an aggregate defense budget of £349 billion from 1988 to 2005.

\textbf{Constant Defense Spending in Real Terms}

Figure 8 illustrates U.K. defense spending in constant pounds since 1955.

\textsuperscript{52}This is notable, of course, because spending as a share of GDP had fallen in almost every year until this plateau was reached.


\textsuperscript{54}2% was chosen somewhat arbitrarily. It is higher than the growth rate since 1965, but lower than that from 1955. Choosing the growth rate of 2.4% for 1955-1987 captures many of the early boom-years following the end of the Second World War and may represent unrealistically high rates.
As Figure 8 illustrates, U.K. defense spending ranged from a low in 1971 of about £11.5 billion to a high in 1986 of about £18.7 billion. Between 1955 and 1979, spending fell in real terms about 1% per year, but remained within a fairly narrow band and averaged £13.4 billion.\textsuperscript{55}

Accordingly, a "natural" level of spending falls between £12.5 and £14.0 billion,\textsuperscript{56} suggesting that future budgets might return to this level.\textsuperscript{57} This seems unlikely, however, unless a major review of U.K. commitments occurs. For example, as this paper explains later, about 75% of the U.K. defense budget is devoted to operations, including personnel, maintenance, minor procurement items, and other overhead costs. The remainder is devoted to purchases of new equipment. Thus, a reduction to a level of £12.5 to £14 billion would force either a drastic reduction in forces and missions, possibly including the retirement of fairly modern equipment or the termination of new equipment purchases.

\textsuperscript{55}The standard deviation is 936. All figures are expressed in £1987. Much of the decrease from 1955 to the early 1970s resulted from the termination of overseas commitments and a steady decrease in Royal Navy assets.

\textsuperscript{56}This range captures about 70% of all data points from 1955-1979.

\textsuperscript{57}A similar argument has been advanced regarding the U.S. defense budget. See Kevin N. Lewis, \textit{What if the Reagan Defense Buildup is Over?} P-7347, The RAND Corporation, 1987.
A less precipitous decline of 1% per year, however, similar to that from 1955 to 1979, however, seems plausible. This low resource scenario would result in average annual spending of £17 billion or an aggregate spending level of £289 billion from 1988-2005.

Defense's Share of General Government Expenditures

The defense budget's historical share of U.K. general government expenditures may also provide insight into past defense and non-defense spending priorities and future defense budget spending. For example, recent increases in non-defense programs, such as health, social security, and education might indicate that it will become increasingly more difficult for the the U.K. defense program to maintain a fairly constant share of general government expenditures.

Figure 9 illustrates program share of general government expenditures since 1967.

---

**Footnote:**

58General government expenditures includes national and local expenditures. Local expenditures have historically accounted for about one-third of general government expenditures.
Defense spending as a share of general government spending has fallen from nearly 15% in 1967 to about 13% in 1987, while some other programs have increased slightly. Social security and housing expenditures\textsuperscript{59} have increased from 27% to 31% of all expenditures. Other categories have remained fairly constant. In short, defense spending's falling share of general government expenditures indicates a decreasing emphasis on defense vis-a-vis other expenditures.

This relative decrease in defense spending has occurred as aggregate general government expenditures have increased. Figure 10 illustrates U.K. general government expenditures as a share of GDP from 1955 to 1990.\textsuperscript{60}

\textsuperscript{59}This somewhat arbitrary grouping since it appears housing has been included in the social security account since 1984.

\textsuperscript{60}1987-1990 data points are based on MoT projections. I am skeptical of the 1986 data which show a very large decrease from 1985. The data does not specify whether it includes privatization credits, although it appears that it does not. Privatization will likely continue for several years and may reduce expenditure up to about 1% per year on average. See The Government's Expenditure plans 1988-89 to 1990-91, Cmnd. 288-l, (London: HMSO, 1988), pp. 55-56, 90-94.
Expenditure peaked in 1975 at just under 49%, while the low point (not surprisingly) occurred in 1955 at 33%. It is notable that the general government’s share of GDP increased in the first years of the Thatcher government—much of this appears to have resulted from high social security payments, including unemployment compensation, during the early 1980s recession. Since 1982, however, expenditure share of GDP has decreased from 46.4% to 42.8%.

A continued reduction in central government expenditures as a share of GDP indicate that programs in general will not be able to increase as rapidly as the economy expands. Of course, individual programs, such as defense, may increase as a share of total expenditures, but only if other programs decrease. Thus, current government policy of further decreasing total government spending limits opportunities for defense budget growth. A Labour government, on the other hand, while less committed to reducing the size of central government, would undoubtedly favor non-defense over defense program expansion.

In sum, defense spending has fallen relative to other spending programs and now averages about 13% of all government spending. The likelihood of a reversal in this trend appears remote.

FUTURE GROWTH IN CENTRAL GOVERNMENT EXPENDITURE CATEGORIES

Future growth in many general government expenditure categories, of course, results from political decisions within participating Ministries and the Houses of Parliament and is thus difficult to forecast. However, certain expenditures are related to demographic and economic factors and may be estimated with a reasonable degree of confidence. For example, the cost of health

---

61I assume that the high levels in 1975 and 1976 resulted from a combination of a recession and increased social spending on unemployment benefits.

62It is questionable, in fact, whether any party would advocate a significant increase in defense spending in the short- to medium-term. A recent poll shows more Britains favoring a cut in defense spending than those who favor an increase. David Fairhall, "Europe Wary of American Nuclear Stance," Manchester Guardian, February 22, 1987, p. 4. 27% favor a decrease in spending, 17% favor an increase, while the remainder are undecided or favor no change in spending.

63Most expenditure categories are inherently unpredictable. For example, expenditure on trade and industry or the environment are difficult to predict. Similarly, forecasts about future agriculture, fisheries, food, or transportation expenditure are speculative. However, these categories constitute a small part of general expenditures.
care and estimates of the total number of future health care recipients provides a useful estimate of future health care expenditures if available benefits remain fairly constant over time.\textsuperscript{64}

Education, social security, and health expenditures account for nearly two-thirds of all general government spending, are related to demographic changes, and can be more easily forecast. Accordingly, future expenditures in these categories may provide some insight into the possible crowding out of defense spending.

**Education**

Education and Science\textsuperscript{65} account for roughly 13\% of all U.K. general government spending. Forecasting future Education and Science spending requires fairly detailed demographic data, but also specific assumptions about the number of students in private schools, attendance rates, average costs per student, and expected increases in teachers' salaries. Appendix A explains the assumptions used in this section to forecast future Education and Science Department spending.

Approximately 75\% of all spending on education and science is directly related to the number of students in public schools in the U.K. The remaining 25\% is explained by various overhead, miscellaneous charges, and other parts of the Science budget.\textsuperscript{66}

If participation rates, the number of students in private schools, and attendance rates at universities and other higher institutions remain constant through 2005,\textsuperscript{67} Education and Science forecasts become quite simple with available demographic data. Education and Science Department expenditure forecasts for 1991, 1996, 2000, and 2005 are listed in Table 12. Table 12 contains

\textsuperscript{64}An alternative approach to this problem would be to perform a regression to determine the relationship between health, education, and social security expenditures and specific demographic groups. This would require an exhaustive review of benefit changes in this category since these changes would directly affect expenditures. Such an effort is beyond the scope of this analysis.

\textsuperscript{65}The Department of Education and Science, specifically.


\textsuperscript{67}Granted, this is a simplifying assumption, but necessary in order to keep this section to a minimum. For further details, see Levitt and Joyce.
2 expenditure forecast variants: the first assumes that teacher salaries do not follow salary increases in the competitive sector, while the second estimates increases at 1.5% per year.\textsuperscript{68}

\begin{table}
\centering
\caption{Forecast of U.K. Education and Science Expenditures}
\begin{tabular}{lcccr}
\hline
\hline
No salary increases (low variant) & 6,800 & 18,630 & 18,000 & 17,365  \\
1.5\%/year increases (high variant) & 17,100 & 19,500 & 19,200 & 19,000  \\
Average Yearly Increase (high variant) & -.1\% & 2.6\% & -.3\% & -.2\%  \\
\hline
\end{tabular}
\end{table}

Under the assumptions stated here, education expenditures will crest in the mid-1990s and remain flat to slightly down through 2005. This may not hold true if several of the assumptions used in the calculations change significantly. However, if the basic cost per student remains flat except for teacher salary increases, there should be no large increase in education expenditures. In fact, education may grow more slowly than the general economy and account for a smaller share of the general budget than it now does. Closer examination of the demographic data explains this relatively flat forecast.\textsuperscript{69} Although the number of under five, other primary, and secondary students increases slightly, the number of university and Advanced Further Education (AFE) students falls.

In short, it does not appear that the education budget will contribute to crowding out defense spending through the year 2005 unless benefits increase greatly, participation rates soar, or teacher salaries increase greatly. The education budget may fall slightly below its current 13\% share of general government expenditures.

\textsuperscript{68}Teacher shortages in Britain may result in higher salary increases. Recently, bonuses have been offered to entering science and math students in hopes that they will choose a teaching career. Bonuses may soon be added to increase the number of students in modern languages. Richard Garner, "Teacher Shortage Confounds British Reform Effort," \textit{International Herald Tribune}, February 18-19, 1989, p. 12.

\textsuperscript{69}See Department of Population annual projections.
Social Security

The U.K. social security system structure closely resembles that in the U.S. and includes contributory and non-contributory benefits.\(^\text{70}\) Contributory benefits include payments to pensioners, which account for 40% of all social security expenditures. Other benefits, such as unemployment compensation, single family support, and housing benefit schemes account for other expenditures. Administrative costs are roughly 10% of all social security expenditures.

Modest growth in social security expenditures will likely occur in the next two decades as the number of people entering retirement increases slightly. Other social security expenditure trends are probably less predictable, although the upward trend in income support for single parents will likely continue. See Appendix A for more detailed information on U.K. social security benefits.

Two models based on demographic data provide insight into future contributory and non-contributory expenditures. The first model estimates that contributory social security expenditures are a function of the number of pensioners. The second estimates that non-contributory expenditures are a function of the number of children. Administrative costs are assumed to be a constant percentage of contributory and non-contributory expenditures.

Contributory benefits will probably increase, albeit only slightly in the coming two decades as the number of pensioners increases. Table 13 illustrates the number of pensioners, children, and workers in the U.K. to 2005.

\(^{70}\)Contributions to the social security account in the U.K. also parallel the U.S. system. Thus, the government may simply increase social security tax contributions if expenditures are expected to increase. Such a situation arguably would not pressure defense and other expenditures unless aggregate spending levels existed. For more general information on social security expenditures, see *The Government’s Expenditure Plans 1988-89 to 1990-91, Social Security Statistics 1987* (London: HMSO, 1987), and Peter Jackson and Francis Terry, *Public Domain* (London: Public Finance Foundation, 1987).
Table 13  
PENSIONERS, CHILDREN, AND WORKERS TO 2005  
(thousands)  

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pensioners</td>
<td>10405</td>
<td>10582</td>
<td>10641</td>
<td>10824</td>
</tr>
<tr>
<td>0-14</td>
<td>10712</td>
<td>11593</td>
<td>11971</td>
<td>11779</td>
</tr>
<tr>
<td>15-64</td>
<td>37415</td>
<td>37378</td>
<td>37697</td>
<td>38168</td>
</tr>
</tbody>
</table>

It indicates a relatively stable population to 2005 with the number of pensioners remaining near 10.5 million. Similarly, the number of children under 15 increases only slightly, while the number of working Britains remains at about 37-38 million.

Current expenditures on contributory social security accounts total about £25 billion. This includes just over £19 billion expenditure on pensioners. The modest increase in the total number of pensioners should lead to a yearly increase of less than one-half of one percent in contributory benefits to nearly £20 billion in 2005. The Treasury's ability to easily increase contributory benefit revenues will mitigate these increases.

Non-contributory benefits may also remain relatively flat, as the number of children remains stable. Closer examination of the data indicates a one-half of one percent increase in the number of children between 1988 and 2005. Thus, non-contributory benefits appear also unlikely to increase at a rate significantly faster than growth in GDP. Of course, a continuation of other trends, such as the

---

71The number of pensioners to workers increases dramatically after 2010. See Appendix A.

72A bias in this model may underestimate the increase in pensions. Specifically, a larger share of women is likely to receive pension benefits in the future and pension costs as a share of the total pension age population may increase. The model also estimates that benefits do not increase as real earnings increase, which seems unlikely. Instead, social security expenditures are likely to follow increases in real earnings, which are assumed to grow at a rate comparable to GDP growth of 2% per year. Even so, this account would increase at the worrisome, but not alarming rate of 3% per year.

73Non-contributory benefits are also related to unemployment rate. I assume that it remains at 1987 levels through 2005.
steady increase in the number of single parent families, might lead to greater increases in non-contributory benefits.\textsuperscript{74} However, there is no significant demographic change which might lead to non-contributory benefit increases between 1988 and 2005.

Table 14 summarizes estimated contributory, non-contributory, and administrative social security expenditure projections to 2005.

Table 14
SOCIAL SECURITY COST PROJECTIONS TO 2005

\begin{tabular}{lcccc}
\hline
\hline
Contributory & 25,600 & 28,480 & 30,850 & 33,800 \\
Non-contributory & 20,165 & 24,220 & 26,940 & 28,560 \\
Administration & 2,100 & 2,195 & 2,410 & 2,640 \\
Total & 47,865 & 54,900 & 60,200 & 65,000 \\
Average Annual Change & - & 2.0\% & 1.9\% & 1.5\% \\
\hline
\end{tabular}

Health and Personal Social Services

Health and Personal Social Services account for 15\% of U.K. general government expenditures. This share will likely grow modestly through 2005 as health care costs and the number of elderly in the population increase.

An aging population and health care cost growth will lead to increases in health care expenditures. While the number of aged in the population will increase only slightly as shown in Table 13, their disproportionate share of total health care costs results in a disproportionately large expenditure increase.\textsuperscript{75}


\textsuperscript{75}For example, the Department of Health and Social Services (DHSS) estimates that it costs nine times as much to care for those 75 and older compared to the working population (ages 15-64). Cited in M.S. Levitt and M.A.S. Joyce, \textit{Public Expenditures: The Next Ten Years}, Discussion paper \#76, pp. 22-23.
Health costs, recently increasing in real terms at an average of 2.5% per year, will contribute to this increase.

Table 15 illustrates Health and Personal Social Service expenditures. Appendix A details these calculations.

Table 15
HEALTH AND SOCIAL SERVICE COST PROJECTIONS

(millions £1987)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24,503</td>
<td>30,672</td>
<td>34,664</td>
<td>39,747</td>
</tr>
<tr>
<td>Average annual change</td>
<td>-</td>
<td>3.3%</td>
<td>2.5%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

It is likely that health costs will increase at a rate near 3% per year, while the most optimistic GDP growth rate is nearer 2%. Health care costs may occupy between 18 and 19% of total general government expenditure in 2005, although this modest increase would probably not contribute to crowding out defense expenditure.

CONCLUSIONS

Non-defense expenditure categories appear unlikely to force reductions in long-term defense spending; however, historical defense budget expenditure data suggest a potential long-term decline similar to that which occurred from 1955 to 1979. This low resource scenario represents an approximate 1% per year decline. Alternatively, the defense budget’s share of GDP may remain relatively constant and defense expenditure will parallel economic growth. In this high resource scenario, defense expenditures would increase at a rate of approximately 2% per year. A middle of the road case estimates defense budget growth at 1% per year.

Figure 11 illustrates these three defense budget growth scenarios. It also illustrates aggregate defense budget funding.
Fig. 11—A projection of defense budget expenditures\textsuperscript{76}

\textsuperscript{76}These use estimated 1990 defense spending, based on MoT projections, as a baseline for determining average and aggregate expenditure.
III. THE BRITISH DEFENSE BUDGET MODEL

The previous section outlined several aggregate defense budget growth scenarios. In this section, historical data\textsuperscript{77} are used to develop a model for U.K. defense spending. This budgetary model projects available funding levels for specific budget categories, including major equipment items as described in Section I. Available resources for major equipment can then be easily compared with requirements for major equipment.

DEFENSE EXPENDITURE CATEGORIES AND MODEL STRUCTURE

The U.K. defense budget can be broken down into three major categories: procurement, personnel, and operations.\textsuperscript{78} An examination of historical data demonstrates a fairly constant division of monies between these three categories, as shown in Figure 12.

![Diagram showing defense expenditure categories over fiscal years from 1971 to 1987. The diagram indicates a constant division of monies between procurement, personnel, and operations.]

\textsuperscript{77}The budgetary model is based on data collected from annual Supply Estimates rather than the Statement on the Defence Estimates.

\textsuperscript{78}The annual Statement on the Defence Estimates lists these categories. The annual Supply Estimates uses a somewhat different breakdown. The 1987-88 Supply Estimates, for example, lists defense expenditure by Parliamentary votes on active personnel, retired personnel, procurement, accommodation services, ship refitting and repair, and sale of government shares in the Royal Ordnance Factories. This analysis relied heavily on the Supply Estimates.
In general, personnel and procurement have each maintained roughly 40% of total expenditures, while operations make up the remaining share. One notable trend is the relative increase in procurement expenditure and the relative decrease in personnel costs. The privatization of some MoD facilities and the subsequent transfer of personnel to the private sector explain this trend in part; however, an increasing defense budget, a more conscious resource allocation policy, and increased use of contractors appear to be the main reason for this trend.

Personnel expenditure categories include active duty, civilian and retired personnel wages, while operations include several miscellaneous categories. Procurement expenditure includes research and development, production, and maintenance. Table 16 illustrates major U.K. defense budget categories and their respective 1987 spending levels. Each category’s share of total defense spending is listed in parentheses.

79 This has been particularly noticeable since 1980.
80 Including BAE, Rolls-Royce, the Royal Dockyards, and the Royal Ordnance Factories. These privatizations apparently did not appreciably alter the share of equipment expenditure since payments to these organizations have always been included in the equipment category. Based on conversations with RAND staff.
82 U.S. budget data, of course, includes maintenance spending with operations. Thus, a comparison of the relative share of procurement across U.S. and U.K. budgets greatly inflates the U.K. procurement share.
Table 16
THE 1987 DEFENSE BUDGET
(in billions of £1987)

<table>
<thead>
<tr>
<th>Expenditure Category</th>
<th>Spending³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spending</td>
<td>18.8</td>
</tr>
<tr>
<td>I. Operations</td>
<td>2.7</td>
</tr>
<tr>
<td>II. Personnel</td>
<td>6.7</td>
</tr>
<tr>
<td>Retired</td>
<td>1.0</td>
</tr>
<tr>
<td>Active duty</td>
<td>4.0</td>
</tr>
<tr>
<td>Civilian</td>
<td>1.7</td>
</tr>
<tr>
<td>III. Procurement</td>
<td>9.4</td>
</tr>
<tr>
<td>A. Misc. procurement, research</td>
<td>1.1</td>
</tr>
<tr>
<td>B. Land systems</td>
<td>1.5</td>
</tr>
<tr>
<td>Development</td>
<td>.3</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>.5</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.3</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.4</td>
</tr>
<tr>
<td>C. Air systems</td>
<td>3.2</td>
</tr>
<tr>
<td>Army, RN systems</td>
<td>.6⁴</td>
</tr>
<tr>
<td>Development</td>
<td>.6</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>1.9</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.7</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.6</td>
</tr>
<tr>
<td>D. Sea systems</td>
<td>2.6</td>
</tr>
<tr>
<td>Development</td>
<td>.5</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>.9</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.6</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.6</td>
</tr>
<tr>
<td>Total major equipment</td>
<td>1.6</td>
</tr>
</tbody>
</table>

³Some numbers are rounded.
⁴This is appreciably higher than the share of procurement expenditure listed in the Statement on the Defense Estimates since the Supply Estimates includes some personnel and associated costs not found in the Statement on the Defence Estimates.
⁵Author's estimate.
As Table 16 demonstrates, procurement expenditure in the U.K. does not include specific service categories, but instead specifies procurement for land, air, and sea equipment. Although these correspond roughly with Army, RAF, and Royal Navy and Marine procurement expenditures, significant differences exist. For example, procurement expenditure for all Royal Navy and Army air equipment occurs in the air procurement category. Similarly, procurement expenditure for RAF air defense systems occurs in the land procurement category. This accounting procedure requires some very minor transfers, for example, of service equipment requirements to maintain consistency with the budgetary model. Appendix B details these accounting changes.

Table 16 also illustrates major equipment expenditure's relatively minor share of the total defense budget. In 1987, for example, only £1.6 billion, or roughly 9% of total spending, occurs on major equipment items. Operations, personnel, and other equipment purchases, including development, maintenance, and minor equipment items account for the remainder.

The remainder of this section describes the defense budget model in detail and contrasts major equipment requirements with major equipment resources. The model estimates funding available for all non-major equipment items and subtracts this from total available funding. The residual represents available funding for major equipment items.

**OPERATIONS**

The operations category contains numerous expenditures, including movements of personnel and equipment, miscellaneous stores, clothing and victualling,\(^{84}\) fuels and utilities, and the maintenance and administrative costs of existing buildings. Additional minor expenditures range from accommodation services, including land and building purchases to third party payments for weather reporting services. Table 17 lists 1987 operations categories and costs.

---

\(^{83}\) Other peculiarities include service responsibility for certain non-warlike stores, including food (purchased by the Royal Navy), and furniture (purchased by the RAF). Based on conversations with RAND staff.

\(^{84}\) Food, in the vernacular.
Table 17
NET 1987 OPERATIONS EXPENDITURES

(in thousands of £1987)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movements of Personnel, Equipment</td>
<td>352,860</td>
</tr>
<tr>
<td>Clothing, Victualling</td>
<td>176,376</td>
</tr>
<tr>
<td>Fuel, Utilities</td>
<td>492,156</td>
</tr>
<tr>
<td>Accommodation</td>
<td>1,480,330</td>
</tr>
<tr>
<td>Other</td>
<td>39,690</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£2,674,116</strong></td>
</tr>
</tbody>
</table>

The share of operations by each of the sub-categories listed in Table 17 has remained fairly constant over time, although variations in world energy prices have led to greater fluctuation in fuel and utilities expenditures. Uncertainty about future fuel price variations makes forecasting this category somewhat difficult, although U.K. North Sea oil reserves would likely mitigate any future global fuel price increases.

The operations share of the total budget has decreased slowly over time, falling from an average of about 20%\(^\text{\textsuperscript{85}}\) in the 1970s to its current level of 15%. Figure 13 illustrates this change.

\(^{85}\)This excludes 1971/2, 1974/5, and 1975/6 data. It is unclear whether these data are an aberration or a collection of data errors since operating expenses for these years are estimated from sources other than the Supply Estimates and Statement on the Defence Estimates. It is conceivable that these represent higher fuel prices following the 1973 Arab oil embargo. In any case, these data are excluded from this average.
Figure 14 illustrates operations expenditures in constant 1987 pounds.
It indicates that expenditures, with the exception of three early years, have remained constant when adjusted for inflation at about £2.8 billion.\textsuperscript{86} In fact, a closer inspection of the data indicates that operations expenditures in the 1970s were often slightly less than those in the 1980s, despite defense budget growth and recent changes in equipment stock.\textsuperscript{87} In short, it appears that operations have remained a constant expenditure value rather than a constant share of total MoD spending. This is not entirely surprising given the general composition of the operations budget. For example, expenditures on accommodations, movements, clothing, general stores, and fuels would be expected to change only marginally in the absence of major shifts in missions, which have not occurred in this time period. The calculations in this section assume constant overhead operations costs of £2.8 billion to 2005.

PERSONNEL EXPENDITURES

Aggregate personnel expenditure, divided into expenditure on active forces, civilian MoD, and retired personnel, has recently begun to occupy an increasingly smaller share of total defense expenditures. From 1971 to 1987, average personnel expenditures accounted for just over 37\% of all U.K. defense spending, although there has been a clear downward trend in its share of the total budget.\textsuperscript{88} This has occurred as personnel expenditures have remained fairly level or growth slightly in real terms while procurement expenditures have increased greatly. Figure 15 illustrates active, civilian, and retired personnel expenditure share of total defense spending since 1987.

\textsuperscript{86}£1987. See the previous footnote for more information about these aberrations.
\textsuperscript{87}The average operations budget in the 1970s was £2.779 billion; in the 1980s, it has averaged £2.825 billion. The decrease in equipment stock has been modest. In particular, there have been only modest changes in Army and RAF inventories, although the number of major naval combatants has fallen from about 115 in the early 1970s to near 90 in 1987.
\textsuperscript{88}The underlying reasons for this decrease are explained later in this section.
This section estimates future expenditures in these three categories.

**Retired Personnel Expenditures**

Retired pay constitutes non-discretionary spending in the purest sense. For example, the MoD will continue to honor its obligations to retired servicemen and women regardless of the future composition of U.K. missions and equipment assets. The model estimates future retired personnel expenditures based on the future number of service pensioners and pension awards.

Historical data indicate an increase from roughly 213,000 to 226,000 service pensioners since 1971; however, it is unclear whether this trend will continue. The number of pensioners may decrease slightly following the decline in armed forces personnel since the 1950s,\(^{(89)}\) although this may be mitigated by

\(^{(89)}\) A 20 year retirement age is standard. Thus, many service personnel who entered in 1968 will retire this year. However, although this retirement data suggests that the number of pensioners should have begun to decline beginning in the mid-1970s, the opposite is true.
increases in life expectancy. Thus, the total number of pensioners may remain level or increase slightly from 1988 to 2005.\(^9\)

Data on average pension awards, however, indicate an alarming trend. Real earnings per service pensioner has increased 41\%, or an average annual rate of 2.05\% since 1971. This sharp increase has led to retired pay now occupying nearly 15\% of the personnel budget as Figure 16 indicates.

Two factors account for this rapid increase in retired pay. First, the introduction of an all-volunteer force in 1957 likely resulted in more generous pension plans. Pension awards were further improved in the early 1970s, although the effects of these improvements until now have probably been

\(^9\)In fact, increases in life expectancy may account for the increase in the number of pensioners given standard retirement dates and the increase in pensioners since the mid-1970s.
modest. Second, service salaries have increased at a rapid rate since 1979.92 Because pensions are based on final service salary, the pensions of those who have retired since 1979 have paralleled these salary increases.

The budgetary model estimates somewhat optimistically that the number of pensioners remains flat at 226,000. It also estimates that average pensions continue to increase at a rate of 2.05% per year. Thus, in all three budget growth scenarios, retired pay increases at a faster rate that the total defense budget.

Active Force Personnel Expenditures

Active force personnel expenditures constitute just under one-fourth of total defense spending. Forecasting this expenditure category requires information on active force requirements, including needed skill levels, and available resources (military aged personnel).93 This analysis focuses on requirements, based on historical British personnel efficiency measures, and resources, based on the number of military aged people in the population.94

Aggregate active service personnel requirements, based on the number of active service personnel, have decreased since 1971.95 However, the number of active force personnel per major combat unit, such as Army regiments or battalions, RAF aircraft squadrons, and Royal Navy major combatants, does not indicate less personnel intensive active forces or reveal clear trends toward

---

91 Improvements in the early 1970s would affect pensions for pre-1970s enlistees only if the improvements were retroactive. This seems unlikely. Data on 1970s improvements are based on conversation with RAND staff. These improvements will likely only fully be felt in the early-to mid-1990s.

92 The Thatcher government kept its election promise of restoring pay comparability for the armed services.

93 A more detailed forecast requires information on current personnel recruitment problems, retention rates for specific personnel categories, detailed information on average length of service, current recruiting practices, and a host of other information. It would also likely distinguish between recruitment and retention wages and problems. Data limitations necessitate a focus on personnel requirements and military aged personnel.

94 Although it is desirable to include skill requirements in the analysis, data limitations dictate a simpler analysis. Conversations with RAND staff and several news reports indicate an increasingly severe British problem with recruiting and retaining skilled personnel. Thus, this personnel model probably understates wage increases.

95 Assume that the MoD has met its personnel targets since 1971 and that historical active force personnel levels represent satisfactory ones. Reductions in the numbers of Army regiments, major naval combatants and some non-combat aircraft squadrons have likely led to this decrease.
increased personnel efficiency.\textsuperscript{96} This suggests that aggregate British personnel requirements necessary to maintain current force structure to 2005 will remain near current levels.

Figures 17, 18, and 19 illustrate the average number of service personnel\textsuperscript{97} as a share of specific force structure since 1971.

\begin{center}
\includegraphics[width=\textwidth]{chart.png}
\end{center}

\textbf{Fig. 17—Active Army personnel per regiment and battalion}

\textsuperscript{96}There is little doubt, however, that the effective fighting power of individual units has increased with equipment modernization.

\textsuperscript{97}Average active personnel including those in training.
Figure 17 illustrates Army personnel per armoured, artillery, engineering, and infantry battalion or regiment\textsuperscript{98} since 1971 and demonstrates a constant ratio

\textsuperscript{98}British Army regiments and battalions are comparable in size. Thus, they can be combined to assess personnel efficiency.
of about 1450 personnel. In fact, the Army has shown some modest efficiency gains. In the 1970s, this ratio averaged 1515—in the 1980s, it has decreased very slightly to 1472. This represents a decrease of nearly 3%.

Figure 18 demonstrates the number of Royal Air Force personnel per squadron. The larger value represents the ratio of personnel per major combat squadron. This includes strike/attack, air defense, and ground support tactical aircraft squadrons. The smaller value represents all RAF squadrons and excludes only ground defence squadrons.

Neither measure indicates a decrease in the RAF's personnel requirements per squadron. For example, although the ratio of personnel per combat squadron decreased to just above 3,000 in the late 1970s and early 1980s, it has returned recently to nearly 4,000. In fact, the average personnel per major combat squadron has increased slightly from 3466 in the 1970s to 3625 in the 1980s. This represents an approximate 4.5% increase in personnel per major combat squadron.

This ratio also increases when all RAF squadrons are included. As Figure 18 illustrates, this ratio in the 1970s appears slightly below 1500—it has increased to more than 1600 in the 1980s. This represents nearly a 10% increase in personnel per squadron.

Finally, Figure 19 indicates the number of Royal Navy and Marine personnel per major combatant. It also illustrates this ratio excluding Royal Marine personnel. The former indicates a slight increase from just under 700 in 1971 to slightly more than 700 in 1987. The average 1970s ratio is 702, while the average 1980s average is 747. This represents a 6% increase in personnel per major combatant.

Excluding Royal Marine personnel leads to similar results. The ratio increases from a 1970s average of 629 to a 1980s average of 666, a 6% increase. In short, despite the introduction of more modern equipment, it appears that there

---

99 Major combatants include SSBNs, SSNs, SSKs, frigates, destroyers, assault ships, and ASW carriers. The data includes ships in retrofit or on stand-by for retrofit for two reasons. First, a decrease in the relative number of refits since 1971, rather than efficiency gains, may falsely indicate a lower personnel to ship ratio. Second, a small percentage of Royal Navy ships continues to undergo refit. Ignoring these ships ignores Royal Navy refit personnel requirements and may distort personnel requirements. In fact, the ratio of personnel per ship on station has decreased, implicitly indicating an increasingly less efficient (i.e., more personnel intensive) retrofitting process.
has been no decrease in Royal Navy personnel requirements per major combatant.\textsuperscript{100}

In sum, these measurements indicate no aggregate efficiency gains. Although Army personnel per combat unit have decreased 3\% since 1971, RAF and Royal Navy personnel per squadron and major combatant, respectively, have increased as much as 10\%.\textsuperscript{101} The model bases future active force personnel requirements on current requirements and assumes that aggregate personnel requirements necessary to maintain current posture will remain stable to 2005.

The available supply of military-aged personnel, on the other hand, may fall in the near future as the youth cohort\textsuperscript{102} reaches a minimum in 1994. Figure 20 illustrates the decrease in the age 16-19 male cohort from 1988 to 2005. The average drop in the number of males in this cohort from 1988 to 2005 is about 9\%, although its low point in 1994 represents a level about 15\% below that in 1988.

\textsuperscript{100}The RN's ship-to-shore personnel ratio has increased slightly since 1981 from about 42.5\% to 48\%, indicating an overall increase in shore personnel efficiency. Note that this may not be inconsistent with the previous footnote, depending on MoD terminology. Large efficiency increases in shore activities other than retrofitting (administration, etc.) may dominate small retrofitting decreases and result in an overall increase in shore efficiency. See House of Commons Defense Committee, \textit{Defence Commitments and Resources and The Defence Estimates 1985-86}, HC 37-II, (1984-85 Session) (London: HMSO), 1985, p. 75 and yearly \textit{Statement on the Defence Estimates} personnel data.

\textsuperscript{101}These increases have occurred in services which rely greatly on higher technology items and may indicate an increasing personnel requirement despite technological advances.

Because the U.K. relies on voluntary accessions, a falling supply of available labor may lead to two separate increases in the average wage rates of military personnel. Future salaries of military personnel are a function of several factors, including the unemployment rate, real wage increases in the civilian sector, and perhaps some less quantifiable measures, such as levels of patriotism; however, ceteris paribus, a shrinking cohort will lead to wage increases for active force personnel.\footnote{A high youth unemployment rate might mitigate this increase.}

The first increase results from the relative decrease of youth laborers in the economy as a whole.\footnote{The effects of this are already being felt in some industries, especially nursing and teaching. "The old country," The Economist, May 28, 1988.} In simple economic terms, as the supply of youth declines, the equilibrium wage rate increases and the number of youth workers declines. The magnitude of this increase, based on previous RAND research,\footnote{Hong Tan and Michael Ward, Forecasting the Wages of Young Men, R-3115-ARMY, The RAND Corporation, 1985. The model assumes a wage elasticity of .5. In other words, for each percentage drop in the cohort, relative wages increase .5%.} represents the relative wage effect of the declining cohort.
The second increase results from the premium wages the MoD must offer to youth to attract an increased percentage of the youth population to military service. For example, currently the MoD attracts about 7% of the 16-19 year old cohort; however, to maintain the same absolute number of youth workers in the future, the MoD must attract a larger share, perhaps up to 10%, of youth workers.\textsuperscript{106} This wage premium represents the cohort effect.\textsuperscript{107}

In addition to these cohort-related increases, the MoD must continue to pay average wages comparable to the civilian sector or face both an exodus from current active force personnel and a decline in the number of recruits. Historical earnings data provide one estimate of the future earnings of active military personnel due to this pay comparability increase. For example, since 1971, real earnings of the civilian population have paralleled GDP growth, increasing at an average rate of about 2% per year.\textsuperscript{108} Real average military personnel wage increases since 1971 have been smaller, averaging only 1.2% per year,\textsuperscript{109} although increases since 1979 have exceeded civilian pay increases.\textsuperscript{110} Additional hidden wage costs, such as eventual increases in educational benefits or pensions may disguise these data and suggest that aggregate military wage increases, although they have not on the surface kept pace with civilian increases, have likely paralleled civilian wage growth. The model assumes that the MoD must in the


\textsuperscript{107}The magnitude of this cohort effect is based on Tan and Ward's research. This assumes wage elasticities of 0.2 and 4 for enlisted personnel and officers, respectively and is based on an active force of 87% servicemen and 13% officers. Statement on the Defence Estimates 1988, Vol. II, Section IV.


\textsuperscript{109}Increases have been as follows: Royal Navy and Marines, 1.30%; Army, 1.16%, RAF, 1.14%. The weighted average is 1.2%. Weighted average is based upon average strengths of RN/M: 75,000, Army: 166,000, and RAF: 95,000. This represents a very crude estimate of average wages based on personnel expenditure and personnel strength. This may be misleading since about 30% of British active force personnel serve overseas and receive varied overseas allowances. Also significant accounting procedures may distort these figures.

\textsuperscript{110}Based on conversations with RAND staff, pay indices in Statement on the Defence Estimates, and Department of Employment New Earnings Surveys.
future maintain pay comparability in order to remain competitive with the private sector. These future civilian and military wage increases resulting from general economic conditions are based on economic growth and work force composition and are estimated at 1.7% per year.\textsuperscript{111}

This estimated magnitude of the relative wage and cohort effect increases is illustrated in Figure 21. The estimated increase of 1.7% per year due to general economic conditions is not reflected in this figure.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{fig21.png}
\caption{Active force personnel cost growth}
\end{figure}

Figure 22 illustrates active force personnel expenditures assuming the relative wage, cohort, and general economic condition increases described above.

\textsuperscript{111}Based on projected economic growth rates and labor force composition.
It illustrates this high expenditure personnel cost growth scenario, as well as middle and low expenditure cases. This high expenditure case is based on no decline in personnel requirements, as well as significant wage increases resulting from a declining youth cohort. The low expenditure case and a middle-case scenario also assume no changes in personnel requirements, but assume no and modest cohort effects, respectively. This modest cohort effect is simply the average of the low and high expenditure personnel cost scenarios.

Civilian Personnel Expenditures

A forecast of civilian personnel expenditures also depends on personnel requirements, resources, and expected wage growth. This section estimates civilian MoD personnel requirements and civilian wage expenditure.

As noted previously, a sharp decrease in the number of civilian personnel in the MoD in part explains the declining personnel costs in the U.K. since 1979. The number of civilian MoD personnel has fallen since 1971 from 330,000 to an estimated 196,900 in 1987.\textsuperscript{112} It is difficult to assess whether this trend will

\textsuperscript{112}It is projected to fall further in 1988.
continue, although one British analyst suggests that this is unlikely. The most recent expenditure plans seem to confirm this, indicating little additional defense-related privatization or additional use of contractors.

Civilian personnel requirements may continue to fall in the short term, up to perhaps 2% per year; however, this is unlikely to continue on an annual basis to 2005. Current government policy indicates that at least some additional reduction is likely. A high expenditure scenario estimates a 1% per year decline in civilian requirements, while a low expenditure scenario estimates a 2% per year decline to 2005. A middle-case uses the average of the low and high expenditure scenarios.

Historical data indicate that real civilian wages have increased roughly in line with GDP growth, averaging 1.8% since 1971. The model estimates wage growth at 1.7% per year based on future work force composition and projected economic growth.

If civilian wage rates increase at a similar rate in the future, expenditures will decline in the low expenditure scenario, but will increase slightly in the middle and high expenditure scenarios. Figure 23 illustrates civilian personnel expenditure projections.

---


115This represents a total reduction of 29% over 17 years.

116Civilian MoD real wage growth has been quite rapid since 1980, however, averaging more than 5% per year. This apparent steep increase has resulted from the termination of many lower-salaried relative to higher-salaried employees, creating a higher "average" salary.

117These same assumptions were used in estimating future active force wage growth.
PROCUREMENT

The U.K. procurement category has recently grown to more than 50% of total expenditures.\textsuperscript{118} In the early 1970s, procurement averaged in the low- to mid-30% range. Procurement includes all new equipment purchases,\textsuperscript{119} maintenance, and all research and development. This section addresses land, air, sea, and miscellaneous procurement categories.

Miscellaneous Procurement

Miscellaneous procurement includes administrative costs,\textsuperscript{120} some minor contact procurement not covered in other areas, outstation procurement, other minor procurement, and basic research and development expenditures. Figure 24 illustrates miscellaneous procurement spending in constant pounds since 1971.

\textsuperscript{118}The most recent \textit{Statement on the Defence Estimates} excludes some personnel and associated costs and shows a lower percentage.

\textsuperscript{119}This section uses net equipment expenditure data. In some cases, however, net production expenditures for some major equipment items are unavailable and are estimated. For example, land production includes several gross expenditure equipment categories and an aggregate figure for land production aid. (Aid signifies assistance to other countries.) In cases such as this, I assume that land aid is distributed evenly across all gross expenditure categories.

\textsuperscript{120}This includes sales promotion and staff salaries, among other things.
Fig. 24—Miscellaneous procurement expenditure\textsuperscript{121}

It indicates a constant level of spending averaging £1.08 billion. The model estimates continued annual constant pound spending.

Land Procurement

Land Procurement has maintained about an 18% share of MoD procurement expenditure since 1971. It is broken down into development and production categories. Production categories include guns and small arms, ammunition, fighting and load-carrying vehicles, surveillance and communication equipment, guided weapons, other minor procurement, and maintenance.

The development share of land procurement has increased significantly since 1971, as Figure 25 illustrates.

\textsuperscript{121}The hump in 1970 resulted from unusually high Royal Ordnance Factory reserve capacity and indemnities to the U.S.
In the 1970s, it averaged 8.8%, but has now risen to a 1980s average of 15.7%.\textsuperscript{122} The model estimates that the ratio of development to production costs continue to increase, although at only one-half the rate since 1971.

The increased sophistication of many new Army equipment items may explain this increase in development expenditures. For example, in the early 1970s, communication and other electronic equipment took up a relatively small share of total Army production; however, today, communication and surveillance systems alone account for about 20% of all production spending. The introduction of additional high technology items, such as the MLRS I, Rapier upgrades, and the Ptarmigan communication system indicates a continued relative increase in weapon system development to production costs.

Many Army minor equipment items have been funded at fairly constant levels since 1971 and are included as overhead items in the model. For example, expenditures on small arms, ammunition, surveillance, engineering and communications equipment, load-carrying vehicles, and other minor items have increased only slightly in real terms. Some minor equipment items indicate a less

\textsuperscript{122}The 1970 period includes 1971-1978; the 1980s period includes 1979-1987.
than constant level of funding; however, many of these indicate a cyclical funding nature. The model estimates, based on historical data, annual increases in these expenditure categories of 1.8% per year\textsuperscript{123} in the future. Figure 26 illustrates minor Army procurement expenditure. Table 18 lists these minor procurement items and their average expenditure amounts.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig26}
\caption{Expenditure on minor equipment items\textsuperscript{124}}
\end{figure}

\textsuperscript{123}This rate of increase reflects the average increase in constant pounds for these minor procurement items since 1971 adjusted for the high level of Ptarmigan spending from 1984-1987. The model thus assumes that Ptarmigan expenditure was a one-time event and does not include this expenditure in determining average future communication systems expenditure. Average 1971-87 expenditures are also adjusted downward to account for maintenance expenditures not reported in the \textit{Supply Estimates} until 1982. I assume that the early \textit{Supply Estimates} spread maintenance spending evenly across all categories listed under land procurement. Thus, these estimated average 1971-87 may underestimate some category expenditures.

\textsuperscript{124}Other includes communications, surveillance, engineering, and other unspecified procurement items. Two Army production categories, armoured fighting vehicles and guided weapons, remain outside overhead spending in the model.
Table 18
MINOR LAND EQUIPMENT ITEMS

(millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Average expenditure, 1971-1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guns and small arms</td>
<td>44</td>
</tr>
<tr>
<td>Ammunition</td>
<td>238</td>
</tr>
<tr>
<td>Load-carrying vehicles</td>
<td>128</td>
</tr>
<tr>
<td>Communications*</td>
<td>143</td>
</tr>
<tr>
<td>Surveillance</td>
<td>96</td>
</tr>
<tr>
<td>Engineering equipment</td>
<td>67</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£716</strong></td>
</tr>
</tbody>
</table>

*1979 data are estimated. Excludes estimated Ptarmigan expenditures.

Data on the maintenance share of the land procurement budget are limited, although maintenance expenditures accounted for around 14% of 1981-1987 land procurement expenditures. These increased to 17% in 1987. Figure 27 illustrates these levels as a share of total land procurement. Maintenance expenditures have increased their share of land procurement since 1981. The model estimates continued maintenance spending at its 1987 share of land procurement.\(^{125}\)

\(^{125}\)Maintenance costs on more modern items, such as the Challenger tank, may not be less than older Chieftain tanks and maintenance’s share of spending may increase. For example, while field maintenance is apparently less, regular base maintenance is more costly. See House of Commons Defense Committee, *Defence Commitments and Resources and The Defence Estimates 1985-86*, HC 37-II, (1984-85 Session) (London: HMSO), 1985, p. 203.
Fig. 27—Maintenance share of land procurement

Note: Data unavailable between 1972 and 1982.

In sum, the model accounts for development, maintenance, and minor equipment procurement. Residual land procurement expenditure, about 25% of total land procurement funding, is available for the procurement of major items, including all armoured vehicles and guided weapons.

Air Procurement

Air procurement, including development and production expenditures, has maintained an average 45% share of MoD procurement since 1971. Air production includes spending on fixed wing aircraft, helicopters, avionics and electronic equipment, guided weapons, and maintenance and support.

The Air Procurement category includes air equipment expenditures for the Royal Navy's Fleet Air Arm and for the Army, such as Sea Harriers and support helicopters. According to recent testimony in Parliamentary hearings,126 these

expenditures account for 20% of the Air Procurement budget. Thus, RAF air procurement totals only about 80% (about £2.8 billion in FY87) of the total air procurement budget. The budgetary model reflects this procurement on behalf of other services.

Air development expenditures have averaged 19% of total RAF air procurement since 1971, as Figure 28 illustrates. Development spending occupied a greater share of total air procurement in the 1970s, probably as a result of the Tornado's early development phase. The average in the 1970s was 22.6%, and this has fallen to just over 15% in the 1980s.\textsuperscript{127} The model assumes a 19% development share of air procurement.

\textsuperscript{127}Approximately two-thirds of Air Procurement development funding has been spent on aircraft development. The remainder has been spent on weapons, avionics, and other items. For the purposes of this analysis, I have assumed that air development continues to occupy 19% of all air procurement expenditure. This level of funding may not be sufficient for RAF future plans. Specifically, EFA development cost growth, if similar to Tornado development cost growth, may consume the entire development budget and leave no residual funding for other projects. For example, in the low requirement-high resource scenario (2% defense budget growth), total available RAF development funds from 1988-1998 (EFA development period) will be only about £8 billion. Even if this is devoted entirely to EFA, this may be insufficient given Tornado development cost estimates of £6 billion. This, of course, assumes EFA development costs greater than those for Tornado. See AAS, Milavnews, Vol XXII, NL-255/1/83, p. 17.
Expenditure on aircraft weapons, avionics, and other electronic equipment production occupies a significant share of the total RAF air procurement budget. Figure 29 illustrates the share of these relative to total air procurement expenditures since 1971.
After falling to a low of 12% in 1975, this category's share of total air procurement steadily increased to an average of 24% in the 1980s. Of course, some of this later increase can be attributed to the decrease in aircraft production spending as the Tornado entered service; however, increased weapons, avionics, and other electronic equipment spending began long before Tornado peak spending occurred in the late 1970s and early 1980s, indicating that this would have occurred in the absence of Tornado as well. The model estimates that aircraft weapons, avionics, and other electronic equipment continue to take up the historical average of 19% of all air procurement funding.\textsuperscript{128} In short, the model conservatively estimates that weapons, avionics, and electronic equipment costs for future air equipment items remain flat relative to expenditures on aircraft platforms.

Finally, although only limited data are available, I have estimated air support and maintenance at 24% of all RAF air procurement. Figure 30 illustrates maintenance spending.

\textsuperscript{128}This is likely too conservative an estimate, given recent estimates that avionics alone may account for about 50% of spending on the EFA. In short, avionics, weapons, and electronic equipment expenditure may exceed aircraft platform expenditure.
Fig. 30—Air support and maintenance share of air procurement

Note: Data unavailable prior to 1984.

In sum, the model accounts for all air development, weapons, avionics, electronic equipment, and maintenance spending. The remainder of air procurement funding, approximately 38%, should be available for the purchase of all platforms, including helicopters for the Royal Navy, RAF, and the Army.\textsuperscript{129}

**Sea Procurement**

Sea procurement has taken up about 23% of all MoD procurement expenditure since 1971. Sea Procurement includes development and production spending, and production is broken down into spending on new equipment, such as hulls and weapon systems, and overhead spending, such as maintenance, miscellaneous stores, and other minor procurement items.

Sea development spending as a share of total sea procurement spending is show in Figure 31.

\textsuperscript{129}Excluding RN and Army platforms, this figure is about 23%.
Fig. 31—Sea development share of sea procurement spending

Figure 31 demonstrates sea development's increasing share of total sea procurement from a level near 12% in the early 1970s to recent levels of just under 20%. Development's share averaged 11.9% in the 1970s, but has risen to 18.6% in the 1980s, an average yearly increase in development's share of total procurement of just over 2.6%.\textsuperscript{130} It is uncertain whether this trend will continue into the next two decades. However, increasingly complex shipborne weapon systems indicate continued development costs growth.\textsuperscript{131} The model estimates continued development growth in relation to production, albeit at one-half the rate from 1971-1987.

Sea production's share of total sea procurement will fall as development costs increase; however, production will nevertheless maintain about three-quarters of total procurement. A significant portion will be taken up by overhead items, such as maintenance and minor procurement. The remainder will be


available for the production of major equipment, such as hull production of diesel attack submarines (SSKs), nuclear attack submarines (SSNs), nuclear ballistic missile carrying submarines (SSBNs), and surface ships.¹³²

Shipborne weapons have taken up about one-third (32%) of total sea procurement expenditure since 1971, as Figure 32 illustrates.

Fig. 32—Sea weapons systems' share of sea procurement

The model estimates that this share remains stable to 2005.

Maintenance and other support for sea systems similarly have maintained a stable share of total sea production, as shown in Figure 33.

¹³²Procurement for RN/M air systems is included in the Air Equipment section, as the previous section and Appendix B explain.
Fig. 33—Sea systems' maintenance share of sea production

In the 1970s, maintenance and other support averaged just under 26% of sea production; in the 1980s, it has fallen, albeit only slightly, to just under 24%.\textsuperscript{133} There is no apparent trend in maintenance or support, nor is there any reason to expect any significant change in the future;\textsuperscript{134} therefore, I have assumed that maintenance and support maintain roughly a the 1980s average 24% share of total sea production.

In sum, the budgetary model accounts for ship development, weapons and minor systems procurement and all maintenance and support costs. These items currently account for about 78% of all sea procurement, leaving 22% of sea procurement funding for the procurement of ship hulls, including major surface combatants and submarines.

\textsuperscript{133}Lower maintenance costs may have resulted from a decrease in the number of RN ships.
\textsuperscript{134}This again is a conservative assumption. Support and maintenance costs may rise as more modern, technologically advanced systems are introduced.
THE MODEL AND AVAILABLE FUNDING

Table 19 repeats 1987 defense expenditures, summarizes the budgetary model and provides an example of available resources in the middle-case scenario.
Table 19
THE BUDGETARY MODEL—MIDDLE-CASE

(in billions of £1987)\(^a\)

<table>
<thead>
<tr>
<th>Expenditure Category</th>
<th>1987 Spending</th>
<th>Middle-case, 1988-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total spending</td>
<td>18.8</td>
<td>327.2</td>
</tr>
<tr>
<td>I. Operations</td>
<td>2.7 (14%)</td>
<td>47.1 (14%)</td>
</tr>
<tr>
<td>II. Personnel</td>
<td>6.7 (36%)</td>
<td>130.0 (40%)</td>
</tr>
<tr>
<td>— of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>1.0 (5%)</td>
<td>21.1 (6%)</td>
</tr>
<tr>
<td>Active duty</td>
<td>4.0 (21%)</td>
<td>80.9 (25%)</td>
</tr>
<tr>
<td>Civilian</td>
<td>1.7 (9%)</td>
<td>28.0 (9%)</td>
</tr>
<tr>
<td>III. Procurement</td>
<td>9.4 (50%)</td>
<td>150.1 (46%)</td>
</tr>
<tr>
<td>— of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. Misc. procurement, research</td>
<td>1.1 (6%)</td>
<td>18.4 (6%)</td>
</tr>
<tr>
<td>B. Land systems</td>
<td>1.5 (8%)</td>
<td>27.6 (8%)</td>
</tr>
<tr>
<td>— of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>.3 (2%)</td>
<td>5.1 (2%)</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>.5 (3%)</td>
<td>14.0 (4%)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.3 (2%)</td>
<td>4.6 (1%)</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.4 (2%)</td>
<td>4.0 (1%)</td>
</tr>
<tr>
<td>C. Air systems</td>
<td>3.2 (17%)</td>
<td>69.8 (21%)</td>
</tr>
<tr>
<td>— of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Army, RN systems</td>
<td>.6 (3%)</td>
<td>14.0 (4%)</td>
</tr>
<tr>
<td>Development</td>
<td>.6 (3%)</td>
<td>10.6 (3%)</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>.9 (5%)</td>
<td>13.4 (4%)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.7 (4%)</td>
<td>16.6 (5%)</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.6 (3%)</td>
<td>19.0 (5%)</td>
</tr>
<tr>
<td>D. Sea systems</td>
<td>2.6 (14%)</td>
<td>34.2 (10%)</td>
</tr>
<tr>
<td>— of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development</td>
<td>.5 (3%)</td>
<td>7.2 (2%)</td>
</tr>
<tr>
<td>Minor equipment</td>
<td>.9 (5%)</td>
<td>10.8 (3%)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>.6 (3%)</td>
<td>8.3 (3%)</td>
</tr>
<tr>
<td>Major equipment</td>
<td>.6 (3%)</td>
<td>7.9 (2%)</td>
</tr>
<tr>
<td>Total major equipment</td>
<td>1.7 (9%)</td>
<td>27.0 (8%)</td>
</tr>
</tbody>
</table>

\(^a\)Some numbers are rounded and may not sum to 100.
The model estimates resources for the production of ship and submarine\textsuperscript{135} hulls, armoured vehicles, Army guided weapons, and RAF platforms. As indicated, approximately £27 billion is available for major equipment production in the middle-case scenario.

THE RESOURCE-REQUIREMENTS IMBALANCE

Service-wide shortfall

Section I estimated the total major equipment requirements for British services for the next 17 years. Some minor accounting adjustments, due to differences between service and geographic procurement accounts, as highlighted in Appendix B, are necessary in order to contrast these requirements with available resources. These accounting adjustments result in a slight decrease in requirements. Table 20 illustrates major equipment requirements for British land, air, and sea procurement accounts and contrasts these with resources as estimated by the defense budget model.

\textsuperscript{135}It excludes all Trident expenditures, including missiles, etc. since Trident is an additional budgetary expense not shown in the historical data.
Table 20
MAJOR EQUIPMENT FUNDING SHORTFALL

(in millions of £1987)

<table>
<thead>
<tr>
<th>Resources</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
<td>(35,197)</td>
<td>(26,978)</td>
<td>(15,018)</td>
</tr>
<tr>
<td>Low</td>
<td>(38,590)</td>
<td>-3353</td>
<td>-11,988</td>
</tr>
<tr>
<td>Middle</td>
<td>(47,195)</td>
<td>-11,612</td>
<td>-20,217</td>
</tr>
<tr>
<td>High</td>
<td>(58,760)</td>
<td>-23,572</td>
<td>-32,177</td>
</tr>
</tbody>
</table>

Table 20 indicates a variety of resource-requirements results. Available resources for major equipment, as calculated in the budgetary model, are listed across the top. These high, middle, and low resource scenarios incorporate corresponding personnel cost growth scenarios as explained earlier.\textsuperscript{136} Note that middle-case resources for major equipment items, as calculated in the previous section, total nearly £27 billion. Requirements for major equipment, as estimated in Section I and adjusted from service to geographic requirements are listed along the left side of the table. In the middle-case, major equipment requirements total just over £47 billion. As the table indicates, the middle-case results in a £20 billion shortfall. A low requirement-high resource case results in a £3 billion shortfall, and a high requirement-low resource scenario results in a £44 billion shortfall.

**Individual Service Shortfalls**

An examination of budgetary shortfalls for land, air, and sea equipment roughly indicates service shortfalls. Such an assessment is speculative since a

\textsuperscript{136} The low expenditure case includes no cohort effect on wages and a 2\% per year civilian force reduction; the high expenditure case assumes that the declining cohort increases wages and the number of civilian personnel declines at only 1\% per year.
1985 MoD reorganization established a more centralized resource allocation process. Although this centralized allocation process casts doubt on each category's (or service's) ability to maintain its historical share of MoD procurement funding, remaining institutional pressures suggest and recent data indicate a rough continuation of this historical division of the procurement budget.

Tables 21, 22, and 23 illustrate land, air, and sea equipment funding shortfalls, respectively, based on historical shares of the MoD procurement budget. The sea equipment budget appears the greatest underfunded, based on continued historical shares of the MoD procurement budget. Air equipment, on the other hand, experiences surpluses or modest shortfalls in about one-half of the scenarios, and seems likely to achieve its modernization goals if it maintains its historical share of MoD procurement funding. Land equipment experiences modest to significant shortfalls in all scenarios.
Table 21
LAND EQUIPMENT FUNDING SHORTFALL

(in millions of £1987)

<table>
<thead>
<tr>
<th>Requirements</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>(7,529)</td>
<td>(3,938)</td>
<td>(1,218)</td>
</tr>
<tr>
<td>Middle</td>
<td>(8,605)</td>
<td>-1,076</td>
<td>-2,566</td>
</tr>
<tr>
<td>High</td>
<td>(10,095)</td>
<td>-4,667</td>
<td>-6,157</td>
</tr>
<tr>
<td></td>
<td>(11,975)</td>
<td>-7,387</td>
<td>-8,877</td>
</tr>
</tbody>
</table>

Table 22
AIR EQUIPMENT FUNDING SHORTFALL

(in millions of £1987)

<table>
<thead>
<tr>
<th>Requirements</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>(18,252)</td>
<td>(15,167)</td>
<td>(8,413)</td>
</tr>
<tr>
<td>Middle</td>
<td>(12,210)</td>
<td>6,042</td>
<td>2,612</td>
</tr>
<tr>
<td>High</td>
<td>(15,640)</td>
<td>2,957</td>
<td>-473</td>
</tr>
<tr>
<td></td>
<td>(20,395)</td>
<td>-3,797</td>
<td>-7,227</td>
</tr>
</tbody>
</table>
Table 23

SEA EQUIPMENT FUNDING SHORTFALL

(in millions of £1987)

<table>
<thead>
<tr>
<th>Requirements</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>(9,416)</td>
<td>(7,873)</td>
<td>(5,387)</td>
</tr>
<tr>
<td>Middle</td>
<td>(17,775)</td>
<td>-8,359</td>
<td>-12,044</td>
</tr>
<tr>
<td>High</td>
<td>(21,460)</td>
<td>-9,902</td>
<td>-13,587</td>
</tr>
<tr>
<td></td>
<td>(26,390)</td>
<td>-12,388</td>
<td>-16,073</td>
</tr>
</tbody>
</table>

The conservative nature of the model and conservative assessments about major equipment requirements almost certainly understate the magnitude of these funding shortfalls. For example, the model uses optimistic assumptions about retired pay, operations, munitions and many other minor procurement items expenditures, and it assumes land and sea development cost growth increases at only one-half the historical rate. These assumptions likely overstate available major equipment resources. Similarly, the model estimates constant maintenance shares of procurement categories, although some evidence suggests maintenance share costs are likely to increase.

Conservative requirement estimates also contribute to understating budgetary shortfalls. As indicated in Section I, for example, items already in production were assumed to incur no additional cost growth. As outlined earlier, modest cost growth after initial production is not uncommon. Finally, requirements over such a long time period invariably tends to understate requirements in distant out-years. For example, although this paper focuses on requirements from 1988 to 2005, a disproportionate share of requirements, namely 95%, falls in the first 12 years, or 70% of the time period. This also understates eventual requirements.
Each table indicates a fairly wide range of shortfalls, although these can be narrowed. For example, the service-wide table indicates a low requirement-high resource shortfall of £3 billion. This assumes, in short, the best of many worlds—2% per year real defense budget growth, no minor or major equipment cost growth, and no increase in active force wages despite the declining youth cohort. The likelihood of these occurring simultaneously seems quite remote.

The shortfalls indicated in the lower right-hand part of each table appear more likely to occur. Requirements based on modest equipment cost growth of 3.5% to 7%, as indicated by the bottom two rows, appear more the norm than the exception. In particular, it is more appropriate to place greater weight on these resource estimates as a surrogate for minor equipment cost growth.

On the resource side, the U.K. has maintained 2% per year or greater defense budget growth for only 6 consecutive years in the last 33—the likelihood of 17 consecutive years of this level of growth is small. Moreover, historical evidence strongly suggests flat or possibly negative budget growth. Thus, the range can be reduced to equally plausible shortfalls between £20 and £44 billion. The arithmetic average of these is £32 billion, or an annual shortfall of nearly £2 billion. Overcoming this projected shortfall requires additional annual budget growth of more than 8% per year.

\[137\text{1979-1984 inclusive.}\]
IV. REACTIONS TO THE BUDGET SHORTFALL

A significant funding shortfall will force MoD planners to make difficult choices, ranging from stretching out procurement purchases to more drastic measures, including abandoning missions. Increased efficiencies might reduce the need to take such drastic action, although the gains from this appear limited. This section briefly examines how the British might cope with a significant defense budgetary shortfall.

INCREASED EFFICIENCY

There are several possible avenues for increasing the efficiency of the U.K. defense effort. These include a more efficient U.K. procurement process, the establishment of more efficient cooperative weapons programs, and the improved use of military personnel. The magnitude of the shortfall may also be reduced through increased weapons trade or weapons production specialization among NATO members. Specifically, members might save considerably if countries produced equipment at which they are the most efficient. This is obviously very difficult politically, although it remains an option which NATO members may be forced to consider more seriously if budget crises intensify.\(^{138}\)

A more efficient U.K. procurement process may mitigate the shortfall, although the likelihood of savings sufficient to offset a significant shortfall is remote.

The 1985 reorganization of the MoD instituted several changes intended to streamline the procurement process and to reduce institutional barriers within the MoD.\(^{139}\) Perhaps the most significant step in the reorganization was the establishment of the Office of Management and Budget within the MoD. The OMB, unlike its U.S. counterpart, has replaced the individual service staffs in

\(^{138}\)It is difficult to imagine the U.K. (or the French or Germans) buying off-the-shelf major weapon systems from its allies. A purchase of the Super Hornet, for example, instead of EFA would in all likelihood be less costly, although it would decimate much of the European aerospace industry.

evaluating equipment requests and serves as the centralized planning organ in MoD procurement policy. This may lead to savings.

Increased competition in U.K. defense industries may also mitigate any budget shortfall. However, the small number of contractors limit these savings. The magnitude of these savings through increased competition is unclear. In general, the House of Commons seems skeptical of the total savings from competition,\(^{140}\) while the MoD is encouraged by the prospects of future savings.

Increased efficiency in more efficient collaborative projects might also mitigate a budgetary shortfall. The U.K. has entered into several cooperative arrangements for the production of weapons, and it is likely that the number of these will increase. In theory, of course, cooperative arrangements spread the fixed costs of systems across all participants and thus reduce program unit costs. For example, spreading the research and development costs for EFA across the U.K., FRG, Spain, and Italy might reduce U.K. program costs by perhaps 33\%.\(^{141}\)

In reality, however, cooperative programs are often less efficient than envisioned for several reasons. First, cooperative programs assume that participating members agree on the precise nature of the final product. Differences in national requirements, such as aircraft weight or mission objectives, often complicate the concept formulation and development phase, leading to a more costly and perhaps less capable final product. Second, cooperative programs are subject to economic and political pressures within participating nations. For example, participants may disagree over the location of production facilities or the production responsibilities of participants.\(^{142}\) Invariably, political forces seem to prevail, resulting in an inefficient allocation of resources and a higher final unit price. In short, although cooperative programs should result in lower total expenditures, this may not occur in practice.

\(^{140}\)A recent HC report claims that the Hesseltime reforms will save only enough by the 1990s to buy and operate one main battle tank. This is obviously hyperbole, but reflects HC skepticism. See AAS, Milavnews, Vol. 23, NL-277/11/84, p. 11.

\(^{141}\)Current estimated U.K. development and production costs for the U.K. share of EFA are £2 and £6 billion, respectively. Other participant R&D costs are estimated at about £4 billion. Thus, this venture should in theory reduce total U.K. costs from £12 to £8 billion.

\(^{142}\)For example, Spain has refused to sign the EFA memorandum of understanding until other participants more fully recognize its concerns about EFA engine production.
Manpower efficiency gains are important if the U.K. is to limit the increases in active force personnel expenditures; however, as noted in the previous section, the outlook for future efficiency gains, based on historical evidence, appears limited. Savings may occur with the more efficient use of reserve forces\textsuperscript{143} and with further reductions in the civilian force. Recent efforts to increase the size of the Territorial Army may aid in limiting personnel cost increases, although demographic factors appear likely to complicate any reduction in personnel costs. Finally, savings achieved through more efficient personnel policies appear to provide only modest savings. A 10% reduction in active force requirements would, for example, save perhaps £8 billion,\textsuperscript{144} far less than shortfalls in the tens of billions of pounds.

In sum, efficiency gains may mitigate a future defense budget shortfall, although the outlook for a significant contribution toward this reduction by individual efficiency measures is not promising. Taken together, these measures would certainly contribute to a more efficient defense operation, although the likelihood of success in each of the areas highlighted seems remote.

STRETCHING OUT NEW EQUIPMENT PURCHASES

Defense planners often react to financial shortfalls by "stretching out" new equipment purchases, or as British planners say, by "pushing it to the right" (of the ledger). Delaying production runs and initial operating dates allows planners to avoid near-term shortfalls at the expense of future resources and current force structure. Force structure suffers since equipment in need of replacement must remain in operation beyond its normal and perhaps useful operational lifetime. Future resources, depending on precise financing arrangements,\textsuperscript{145} may be carried forward to cover current requirements. This postpones the inevitable decisions about future force structure and may damage long-term force planning.\textsuperscript{146}

\textsuperscript{143}The Labour Party would like to utilize more reserve forces which might reduce costs somewhat. See, for example, Defence without the Bomb: A Report of the Alternative Defence Commission (New York: Taylor and Francis), 1983. It is far from clear, however, that "reserve-heavy" forces are less costly than those with few reserves. For example, training costs and personnel salaries may rise in such scenarios.

\textsuperscript{144}Based on expenditures of £80 billion in the middle case.

\textsuperscript{145}Precisely, if today's requirements are paid for with tomorrow's money.

\textsuperscript{146}For example, current force structure may be far greater than a nation can sustain in the long-term. Pushing equipment purchases to the right may permit some short- to medium-term
In the middle-case scenario outlined in this paper, the British might choose
to postpone several new equipment purchases in reaction to an anticipated
shortfall. The projected shortfall, £20 billion, could be substantially reduced by
postponing equipment purchases illustrated in Table 24.

Table 24
SAVINGS FROM EQUIPMENT POSTPONEMENTS
(millions of £1987)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Projected IOC</th>
<th>Costs</th>
<th>New IOC</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>EFA(^a)</td>
<td>1999(^b)</td>
<td>8825</td>
<td>2004</td>
<td>7060(^c)</td>
</tr>
<tr>
<td>FFLA(^d)</td>
<td>1997-8</td>
<td>1470</td>
<td>2003</td>
<td>735(^e)</td>
</tr>
<tr>
<td>Trigat</td>
<td>1995</td>
<td>395</td>
<td>2003</td>
<td>200(^e)</td>
</tr>
<tr>
<td>SSN20</td>
<td>1998</td>
<td>3245</td>
<td>2005</td>
<td>1630(^e)</td>
</tr>
<tr>
<td>NFR-90</td>
<td>1997</td>
<td>2455</td>
<td>2002</td>
<td>810(^f)</td>
</tr>
<tr>
<td>ASW Frigate</td>
<td>2002</td>
<td>2430</td>
<td>2007</td>
<td>2430</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>42,865</strong></td>
<td></td>
<td></td>
<td><strong>712,865</strong></td>
</tr>
</tbody>
</table>

\(^a\)Air defense and ground attack variant.
\(^b\)Average of air defense and ground attack variant IOC.
\(^c\)Based on payment on 50 aircraft before 2005.
\(^d\)Replacing Ferret, Scorpion, Fox.
\(^e\)Assumes 50% purchase prior to 2005.
\(^f\)Assumes 33% purchase prior to 2005.

As Table 24 indicates, the postponement of several major equipment
purchases by as much as eight years greatly reduces the projected shortfall in the
middle-case. However, the costs of these postponements are also significant. For
example, a postponement of EFA to 2004 would force the RAF to continue to fly
some Phantom air defense squadrons to perhaps as late as 2007, when the
Phantom's average age would reach 37 years. Clearly, the effectiveness of the
Phantom in its air defense role would be brought into question.\(^{147}\)

benefits, although in the long term, more difficult choices must be made and invariably more
precipitous reductions must follow as the budget crisis becomes more severe.

\(^{147}\)If the British are able to meet the EFA timetable, Phantoms would retire at 32 years of
age. Some might argue convincingly that a Phantom at 37 years of age is comparable to a
Phantom at 32 years; however, the most important aspect of an EFA postponement is that it is a
Postponement of Army or Royal Navy equipment as indicated would have similar effects. Ferret and Scorpion AFVs and nuclear-powered attack submarines (SSNs) would remain in service until an approximate 30 year mark.

REDDUCING READINESS

The British might also reduce a shortfall by cutting the readiness of its forces. In particular, the British might decrease maintenance and munitions expenditures in order to accommodate major equipment purchases.

As the budgetary model demonstrated, the British spend a large portion of their budget on maintenance and munitions. Table 25 illustrates the share of the land, air, and sea equipment budgets typically designated for these items and savings resulting from 50% reductions in munitions and maintenance spending in the middle-case scenario.

Table 25
SAVINGS FROM READINESS REDUCTIONS, 1988-2005

<table>
<thead>
<tr>
<th>Category</th>
<th>Munitions</th>
<th>Maintenance</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>2.8</td>
<td>2.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Air</td>
<td>6.7</td>
<td>8.3</td>
<td>15.0</td>
</tr>
<tr>
<td>Sea</td>
<td>5.4</td>
<td>4.2</td>
<td>9.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29.7</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aAmmunition category expenditures.
bAuthor's estimate.

As Table 25 indicates, reductions in both maintenance and munitions expenditures result in savings sufficient to eliminate or to significantly reduce the middle-case and high requirement-low resource case shortfalls, respectively.

postponement of an eventual reduction in RAF structure. Stretch-out after stretch-out would eventually result in 50 year old fighter aircraft on many frontlines and this is without question undesirable. Older aircraft also require additional maintenance — at this age, the aircraft would likely spend a great deal of time in hangars rather than on-station ready for combat.
These estimates are, of course, highly suspect since it is highly unlikely that munitions and maintenance expenditures could be reduced by these large amounts. It is, however, without question undesirable to consider reducing readiness precisely at the time the importance of conventional forces is increasing.

ABANDONING MISSIONS

Abandoning specific missions and force restructuring in each of the services may be considered as a last resort. Those missions currently discussed include reductions in British Army of the Rhine (BOAR), Army out-of-area, RAF ground attack, and Royal Navy blue water missions.

The Royal Navy is perhaps the most vulnerable to reductions in forces and missions.148 In late 1987, the MoD announced that it would not order the 3 frigates necessary per year to maintain the current surface fleet.149 The U.K. may slowly build down to a much-reduced surface Navy, or in the extreme case, the U.K. may choose to maintain only its submarine forces and homeland patrol boats. Phasing out the surface fleet's blue water mission150 would reduce RN procurement requirements by at least £10 billion (approximately £5 billion each for ships and weapons) over the next 17 years. Operations and personnel savings would probably total nearly £1 billion per year,151 for a total reduction of £27 billion. These savings would eliminate most shortfalls and allow the RAF and Army to actively modernize their forces. This alternative, of course, greatly reduces British naval forces, which supply 70% of NATO's early front-line naval forces and would play a major role in forward defense strategy. Such a measure would greatly increase the likelihood of Soviet forces escaping from the Norwegian Sea and attacking reinforcement ships in the North Atlantic.

---

A possible, yet remote possibility exists that the U.K. might consider Trident cancellation, although this appears extremely remote.\(^{152}\) Cancelling Trident (which is far from the minds of virtually all the political leadership) would result in equipment savings of just under £6 billion. Operations savings might total £4 billion between 1994 and 2005. A Trident cancellation by a Labour government after the next elections in 1991 or 1992 also seems unlikely since savings would total less than £3 billion. The Labour Party does remains opposed to Trident, although recent reports indicate that Labour would not scrap Trident if given the opportunity.\(^{153}\) Previously, the Labour party had claimed that Trident will reduce conventional force strength by 30%\(^{154}\) and strongly supported program termination.

The costs of maintaining the BOAR at its current strength are estimated at about £2 billion per year.\(^{155}\) Reducing its strength by 50%, as some have suggested, would result in savings of near £1 billion per year only if these forces were disbanded. This alone would be sufficient to go forward with many Royal Navy and Royal Air Force equipment requirements. However, a reduced commitment seems unlikely considering the U.K.'s staunch commitment to the 55,000 troop BOAR since 1962.\(^{156}\) Moreover, a reduced British commitment to the continent might lead to fears of similar reductions by other NATO members.

The RAF appears committed to maintaining its current missions, although in the long term, marginal reductions might occur. For example, the Labour Party has argued in favor of a "defensive" RAF, which would fly only air defense

\(^{152}\)During a recent visit to the U.K., several officials and scholars suggested that this idea was not entirely far-fetched; however, I am quite skeptical given Thatcher's commitment to and public support for an independent nuclear force.


\(^{154}\)Neil Kinnock, "How Labour Would Defend Britain," *New York Times*, March 27, 1987, p. 31. This is obviously hyperbole. While the operating (£2 billion) and equipment (£9 billion) costs of Trident over 30 years would reduce opportunities for conventional equipment, the reduction in conventional force equipment budgets is nearer 8%. This is based on reductions of £500 million per year in an annual equipment budget (all non-maintenance items) of £6 billion.


\(^{156}\)The British had planned for a reduction in the BOAR in 1961 to 45,000, but cancelled this following the Berlin crisis. Chris Coker, *A Nation in Retreat*, (London: Brassey's Defence Publishers), 1986, p. 6
missions while also possibly directly supporting ground troops.157 Abandoning the strike and attack missions would reduce RAF spending by perhaps 30%, but would of course be a tremendous loss to the central region's air power. This reduction would also likely lead to a smaller buy of EFA aircraft.

Finally, joint out-of-area operations, such as those in the Falklands,158 require approximately £400 per year and would do little to reduce any significant budget shortfall. Abandoning operations in Cyprus, Hong Kong, Belize, Brunei or the Falkland Islands, would result in minimal savings. It is especially unlikely that the British will consider terminating their presence in the Falklands.

In summary, efficiency savings may mitigate a modest budget shortfall, although a sizable shortfall might lead to significant reductions in U.K. forces and missions, reductions in readiness, or the stretching out of major equipment purchases, or a combination of these actions. Political indicators point toward further reductions in the Royal Navy's surface fleet, although this is far from certain. In the long run, however, significant reductions in missions and forces seem inevitable.

---

Appendix A
GENERAL BUDGET EXPENDITURE FORECASTS

This appendix contains additional information regarding general budget forecasts in Section II of the main text.

EDUCATION

About 75% of all spending on education and science can be directly related to the number of students in public schools in the U.K. and the costs per student. This analysis estimated future education expenditures based on six educational groups: under fives, primary, secondary, advanced further education (AFE), university, and those with government awards.

Demographic data for the number of students in each category were obtained from several sources.\(^{159}\) Department of Education and Science (DES) estimates were used when available. Unfortunately, the (DES) data did not contain information on some student group participation rates beyond 1996, and I have estimated participation rates based on earlier DES data. For example, I did not have sufficient data to forecast precise number of Non-Advanced Further Education (NAFE) students and estimated this data from a previous report.\(^{160}\)

Cost estimates per student do not reflect the large real increases in education costs in the U.K. since 1980.\(^{161}\) Thus, the estimates might understate costs per student.

Table A.1 lists participation rates and costs per student in 1987 pounds.\(^{162}\) Table A.2 estimates the total number of students in 1991, 1996, 2000, and 2005.


\(^{161}\)Costs have increased at a real rate of 3.8% per year, according to the government's most recent expenditure plans. See The Government's Expenditure Plans 1988-89 to 1990-91, (London: HMSO, 1988), p. 17.

\(^{162}\)Participation rates for university students may be understated. Recent DES reports expect an increase of 30% in university participation rates in the 1990s. See "Higher Education in Europe," The Economist, July 11, 1987, pp. 19-21.
Table A.1
COSTS PER STUDENT AND PARTICIPATION RATES

<table>
<thead>
<tr>
<th>Group (age)</th>
<th>£1987/Student</th>
<th>Group Participation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5 (0-4)</td>
<td>1132</td>
<td>10%</td>
</tr>
<tr>
<td>Primary (5-10)</td>
<td>854</td>
<td>86%</td>
</tr>
<tr>
<td>Secondary (11-17)</td>
<td>1191</td>
<td>59%</td>
</tr>
<tr>
<td>AFE (18-25)</td>
<td>2716</td>
<td>4.2%</td>
</tr>
<tr>
<td>University (18-25)</td>
<td>5458</td>
<td>4.6%</td>
</tr>
<tr>
<td>Awards (18-25)</td>
<td>360</td>
<td>4.2%</td>
</tr>
</tbody>
</table>

Table A.2
FUTURE STUDENT NUMBERS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Under Five</td>
<td>345</td>
<td>360</td>
<td>400</td>
<td>367</td>
</tr>
<tr>
<td>Primary</td>
<td>3702</td>
<td>4053</td>
<td>4223</td>
<td>4140</td>
</tr>
<tr>
<td>Secondary</td>
<td>2779</td>
<td>3047</td>
<td>3080</td>
<td>3329</td>
</tr>
<tr>
<td>AFE</td>
<td>245</td>
<td>227</td>
<td>235</td>
<td>247</td>
</tr>
<tr>
<td>University</td>
<td>343</td>
<td>310</td>
<td>254</td>
<td>268</td>
</tr>
<tr>
<td>Awards</td>
<td>245</td>
<td>227</td>
<td>235</td>
<td>247</td>
</tr>
</tbody>
</table>

SOCIAL SECURITY

The model described in the text is a simple tool for forecasting future U.K. social security expenditures. The U.K. social security system is terribly complex (as the U.S. system) and a close examination of future expenditures is unfortunately not feasible in this paper. However, a model which bases expenditures on demographic data provides some insight into future expenditures.\(^{163}\)

U.K. social security expenditures is best broken down into three categories: contributory benefits (primarily pension payments), non-contributory payments

(primarily income supplements and family and child benefits), and administrative costs.

**Contributory Benefits**

Contributory benefits include pensions, widows' benefits, some unemployment benefits, industrial injury benefits, and a very small amount of family benefits. Pensions account for roughly 75% of all contributory benefits; thus, the number of pensioners should provide a rough approximation of future contributory benefit expenditures.\(^{164}\)

Pension benefits are available in the U.K. to qualified men 65 years and older and to qualified women 60 years and older. A potential recipient must have contributed to the pension fund to qualify. The model estimates that the ratio of those eligible in 1988 remains constant through 2005. This probably underestimates total eligible recipients since a greater percentage of women work today and will in the future be eligible for benefits.\(^{165}\)

Data from the Bureau of Population Statistics indicate a remarkably stable retired population to 2005. In fact, these data, as well World Bank Population projections\(^{166}\) indicate that the retired to working population ratio in the U.K. will fall slightly between 1990 and 2005 before increasing. Figure A.1 illustrates the U.K.'s retired to working population ratio to 2025.

---


\(^{165}\) However, if more women are eligible, many more women will pay into the fund, as well.

The model assumes that contributory benefits increase at a rate equal to increases in real earnings. This yearly increase is assumed to be 1.5%. This may also (though only slightly) underestimate expenditure. A cursory review of increases over the last 20 years indicates real benefit increases of about 1.9% per year.¹⁶⁷

Since pensions are paid largely from current contributions, estimates of future expenditure requirements may be unimportant. For example, if the pension fund (National Insurance Fund) begins to run deficits, the government can simply increase the fund tax on current workers and net government spending (spending minus revenues) will remain stable. This is not a desirable option if the government is attempting to limit total expenditures.

**Non-contributory Benefits**

Non-contributory benefits include war pensions, disability benefits, income support/social fund, and family and housing benefits. Roughly two-thirds of non-contributory benefits are a function of the number of children in a household; thus, changes in the number of children in the U.K. should provide a useful surrogate measure of non-contributory expenditure growth. The calculations include children up to age 14.

These calculations for non-contributory benefit growth may also be somewhat biased. For example, future non-contributory benefits do not take into consideration social trends already evident. Single parent families are assumed to remain a constant percentage of all families; however, recent evidence indicates an increase in the number of these families. This results in a downward bias. Other recent changes in means tested benefits (MTB) may, however, point to an upward bias in the model. For example, decreases in the number of those eligible for MTB may lead to decreases in the total spending.\textsuperscript{168} Calculations for non-contributory benefits also assume that these benefits increase in line with real earnings growth at 1.5\% per year. This is roughly in line with recent trends.\textsuperscript{169}

\textbf{Administrative Costs}

The model estimates that administrative costs remain about 4\% of total expenditures.

Table A.3 lists estimated social security expenditures in roughly five year intervals to 2005.

\begin{table}[h!]
\centering
\caption{SOCIAL SECURITY EXPENDITURES TO 2005}
\begin{tabular}{lrrrr}
\hline
\hline
Contributory & 25,600 & 28,480 & 30,050 & 33,800 \\
Non-contributory & 20,165 & 24,220 & 26,940 & 28,560 \\
Administrative & 2,100 & 2,195 & 2,410 & 2,640 \\
Total & 47,865 & 54,900 & 60,200 & 65,000 \\
Average Annual Change & - & 2.0\% & 1.9\% & 1.5\% \\
\hline
\end{tabular}
\end{table}


\textsuperscript{169}See \textit{Social Security Statistics 1987}, (London: HMSO, 1987), pp. 62, 162, 167. For example, individual child benefits have increased at just over 1\% per year; Guardian’s Allowance has decreased slightly in real terms; Family Income Supplement has remained flat in real terms.
HEALTH AND PERSONAL SOCIAL SERVICES

Forecasts for future health and personal social services are based on expected real increases in health and personal social service costs and demographic changes and are relatively straightforward.

Initial costs of care on an age-related basis were derived from Department of Health and Social Services (DHSS) statistics.¹⁷⁰

Costs of individual future health care are assumed to grow in real terms at 2.5% per year. This is comparable to recent real growth in the Health and Personal Social Services portion of general government expenditures.¹⁷¹ This ignored possible efficiency gains, as well as unexpected cost increases from additional family practitioner services and other areas of likely benefit growth.

Demographic data were obtained from the Bureau of Population Statistics. Table A4 illustrates social security expenditure forecasts.

Table A.4

HEALTH AND SOCIAL SERVICE COST PROJECTIONS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>24,503</td>
<td>30,672</td>
<td>34,664</td>
<td>39,747</td>
</tr>
<tr>
<td>Average Annual Change</td>
<td>-</td>
<td>3.3%</td>
<td>2.5%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>


There are several minor accounting adjustments necessary to reconcile differences between major equipment service and geographic categories as reported in official MoD and Parliamentary papers and the budgetary model used in this analysis.

There are three major services in the U.K.: the Army, the Royal Air Force, and the Royal Navy and Marines. Section I of this document identified major equipment requirements on a service by service basis.

However, British accounting practices and the budgetary model designate land, air, and sea equipment categories. These correspond roughly with Army, RAF, and Royal Navy procurement, respectively, with two notable exceptions. First, the air procurement category includes all Army and Royal Navy aircraft requirements and resources. Thus, these requirements, listed in Tables 1 (£450 million) and 6 (£850 million), and available resources, shown in the budgetary model, would normally be transferred to the air procurement category. However, since resources for Army and Royal Navy aircraft are excluded from the model's estimate for major equipment items, these requirements are not included in total air requirements. This eliminates any possible double counting and results in a reduction of total air equipment requirements and resources.

Second, the land procurement category includes all RAF air defense surface-to-air missile requirements and resources. Thus, the requirements and available resources for RAF Rapier B2/2000 (£1520 million) would normally be transferred to the model's land category; however, because there is uncertainty regarding the total costs of Army and RAF Rapier upgrades and to avoid possible double counting, only requirements (£1850 million) for Army Rapier SAMs are included in land requirements. This results in a decrease in land requirements, but does not affect land resources as estimated in the budgetary model.

Finally, it is unclear whether the "Guns and Small Arms" land procurement category includes all artillery requirements. This seems unlikely given the relatively small expenditure amounts. However, to avoid the possibility of double counting MLRS and other artillery requirements, I have assumed that this category in the resource model contains artillery equipment. I have thus not included artillery requirements in major Army equipment costs and requirement
totals. At any rate, including artillery modernization costs would have a negligible effect on the model outcome.\textsuperscript{172}

\textsuperscript{172}It would increase the Army's total shortfall £695 over 17 years.