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Sovereignty and Collaboration

Affordable Strategies in Times of Austerity?

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About the Author

Sqn Ldr Gareth Davies joined the Royal Air Force (RAF) in 1996 after graduating from Loughborough University with a bachelor's degree in aeronautical engineering. After completing Initial Officer Training and Basic Flying Training, he was posted to RAF Kinloss, Scotland, where he spent six years on CXX Squadron as a Nimrod MR2 navigator. During this time he conducted operations, in addition to traditional maritime duties, in Afghanistan, the Balkans, and Iraq.

In 2005 Squadron Leader Davies was the first non-pilot in the RAF to be selected to attend the Empire Test Pilots' School, where he graduated as a flight test engineer. In his next tour at the Air Warfare Centre, he served as a trials officer predominantly supporting the purchase of the MQ-9 Reaper and the investigation of the use of tactical unmanned aircraft systems in the maritime (Trial Vigilant Viper) and counter-improvised-explosive-device roles.

In 2008 Squadron Leader Davies joined 39 Squadron as a flight commander operating the MQ-9 Reaper in support of operations in Afghanistan. Afterward, he completed a tour at the Ministry of Defence as the capability desk officer for the Sentinel and RC-135 Rivet Joint. In 2013 he was awarded the RAF Spaatz Fellowship and subsequently completed studies at the USAF School of Advanced Air and Space Studies at Maxwell AFB, Alabama.

Acknowledgments

The genesis for this project came during my time as a capability desk officer in the Ministry of Defence supporting the procurement of the RC-135 Rivet Joint for the Royal Air Force. Early on in my tour it became apparent that there were many differences between the Rivet Joint and the venerable Nimrod R1 that it was replacing. One of the key differences, however, was that the Rivet Joint was designed and developed in the United States. Despite the significant operational capability offered by this new platform, detractors and opportunists—and there were many—continually pointed to a lack of sovereignty as a key deficiency. But what did this mean? This paper is my humble attempt to start to answer that question.

The opportunity to attend the School of Advanced Air and Space Studies has been a truly once-in-a-lifetime experience. While this may seem a cliché to many, spending a year immersed in texts that I would previously never have read and being exposed to the high-quality faculty and students have been opportunities that I will be eternally grateful for. In particular, I would like to thank Dr. Everett Dolman and Col Richard Bailey, PhD, who have offered both guidance and patience during my endeavors.

Finally, it would be remiss of me not to thank my darling wife. Without her enduring humor and support, the experience of the past 12 months would not have been possible or as enjoyable. I apologize; all I can offer in return is that "I promise it will calm down in October."

Abstract

Sovereignty is the authority of a state to govern itself, the ability to operate free from external control. It is a complex and intangible entity that means many things to many people. In terms of military procurement, it is the ability to develop and operate equipment free from the external constraints of other nations. This paper examines sovereignty through the lenses of international theory, policy, and practice to determine whether it is an outdated attribute during times of austerity and if an alternative—collaboration—delivers on its promise of affordability.

The works of realist and liberal economist schools of international relations mark two opposing positions regarding sovereignty and collaboration. On the one hand, realists view sovereignty as an integral component of power; collaboration, on the other hand, increases dependency and thus dilutes power and increases political risk. Liberal economists present the opposite view. They believe that combining diverse and specialist national strengths raises the collective level of performance. However, defense procurement is not a true market economy. Fear of failure necessitates government intervention, and it this involvement that restricts the full benefits of collaboration from being realized.

Recent research reveals a rising advocacy for the liberal position, with academics viewing collaboration as a means of addressing funding shortfalls. This perspective has been mirrored by the United Kingdom defense policy shifting from a protective, mercantile approach to a more liberal exploitation of the global defense market. Despite these policy changes, the evidence presented in this study suggests that the retention of sovereignty remains directed by more domestic political and commercial considerations.

Does collaboration improve affordability? From the evidence presented here, the answer is a qualified yes. Collaboration certainly offers improved potential for short-term affordability but also does not guarantee it. Moreover, evidence suggests that in the long term it is a strategy that will only bend, but not break, the ever-steepening cost curve of military equipment procurement. For this reason, as technological advances continue to diversify national threats and opportunities, the question challenging nation-states in the future will not be whether to resist collaboration in favor of sovereignty; rather, they must decide when to collaborate and what sovereignty to invest in.

Chapter 1

Introduction

A horse! A horse! My kingdom for a horse!

—William Shakespeare
Richard III, Act 5, Scene 4

On 22 August 1485 at the Battle of Bosworth Field, King Richard III led the last charge of knights in English history. Although their historical validity is debatable, Shakespeare's immortal words capture the essence of the moment: a king thrown from his horse and on the verge of defeat. To this day, historians and theater audiences argue whether Richard desired the horse to flee in cowardice or to continue to fight to the bitter end; either way he needed a horse and, in his desperation, was willing to pay any price to any provider. This paper discusses the procurement of military equipment and what price nations—particularly the United Kingdom—will pay to retain sovereignty.

What is sovereignty? The *Concise Oxford English Dictionary* defines it as "supreme power or authority. The authority of a state to govern itself or another state."[1] From the perspective of procuring military equipment, one can interpret this definition in many ways, which can be both ambiguous and emotive. As Robert Cox observes, "The changing face of politics means that sovereignty is a loose concept. The old legal definitions of ultimate and fully autonomous power are no longer meaningful. Sovereignty has gained meaning as an affirmation of cultural identity and lost meaning as power over the economy. It means different things to different people."[2] For example, while the Royal Air Force (RAF) declares the collaborative procurement of the RC-135 Rivet Joint "a vital component of the Nation's future ISTAR [intelligence, surveillance, target acquisition, and reconnaissance] capabilities," public opinion decries the further jeopardizing of sovereign capability due to its reliance on foreign air-refueling tankers.[3] These paradoxical views highlight a developing tension for nations between their ability to afford cutting-edge technology and their ability to use it at a time and place of national choosing. Central to this study are these questions: (1) Has the United Kingdom moved toward favoring collaboration over sovereignty? (2) If so, has it improved affordability? (3) What, if any, are the nonfinancial costs?

These questions are addressed through a fiscal examination of Britain's purchase of military equipment over the past 15 years. Identifying underlying trends and issues for future investments requires particular focus on

sovereign equipment procurement. A review of financial data over the period and supporting case studies leads to three interrelated conclusions. First, from the perspective of equipment procurement, sovereignty is a complex entity. It comes at a price that can be traded in part or in totality through collaborative procurement strategies. In the cycle of design, manufacture, and support, reliance on a foreign entity is highly likely. As a result, very few of the projects reviewed can claim to be wholly sovereign. Second, from academic and policy standpoints, abdication of sovereignty in preference for collaboration has gained increasing prominence as a defensive procurement strategy to counter dwindling defense budgets. Finally, collaboration in equipment procurement is only a short-term defensive measure. While financial pressures may necessitate its use, the intrinsic self-interest of states demands that sovereignty be a financial burden worth carrying for the long term.

Chapter 2 presents international relations theories highlighting the direct link between sovereignty in equipment procurement and national power. In practice, sovereignty of equipment is exercised through either operational advantage or freedom of action. Operational advantage is a nation's ability to procure equipment and operate it while freedom of action is its ability to choose the time and place for the conduct of combat operations. The chapter concludes with a review of recent academic research, which, in summary, identifies that increases in the price of military equipment, coupled with decreasing defense budgets, have caused a crisis in the approach toward sovereignty. Many academics conclude that sovereignty is a liberty that nations can no longer afford and recommend a shift toward the alternative strategy of collaboration.

Chapter 3 examines key policy documents that have defined the British approach toward equipment procurement over the past two decades. Analysis of these documents indicates that since 1991 the United Kingdom's policy has shifted markedly away from sovereignty and toward collaboration. Fundamental to this shift in policy are the nation's attempts to address the increasingly unaffordable nature of complex weapons technology.

Chapter 4 analyzes data compiled from the National Audit Office (NAO) annual major project reports (MPR) from 1999 to 2013 to identify trends in cost and time performance for military procurement projects. Specifically examined are the cost of sovereignty and whether collaboration delivers on its promise of affordability. This analysis shows that, in practice, sovereignty in equipment procurement is a complex concept that rarely appears in a pure form. In fact, there are shades of sovereignty that may be broadly categorized as sovereign, collaborative development, commercial off-the-shelf (COTS), and pooling and sharing. Each category yields an element of sovereignty in

favor of collaboration and, importantly, has affordability considerations. Several trends are identified: (1) despite an apparent shift in policy, at the procurement level very little appears to have changed in approaches to sovereignty; (2) collaboration has the potential to improve affordability but does not guarantee it; and (3) technological challenges are the key factor for adverse changes in cost and time performance for sovereign and collaborative projects alike.

Chapter 5 uses sovereign and collaborative procurement case studies to amplify trends identified in chapter 4. Doing so helps explain why sovereignty is associated with significant cost increases and why, in some instances, the reality of collaboration doesn't follow the theoretical model detailed in chapter 2. Case studies investigated include the procurement of the Type 45 Destroyer, the development of the Eurofighter/Typhoon, Denmark's purchase of COTS ordnance during the Libyan campaign in 2011, and the effectiveness of the North Atlantic Treaty Organization (NATO) Alliance Ground Surveillance (AGS) project.

Chapter 6 considers how the lessons of the past 15 years can be applied to future procurement activities. The twin challenges confronting such efforts will be the escalation of defense acquisition costs and the erosion of technological advantage due to greater availability of high-end commercial technology. Sovereignty and collaboration will each play central roles in addressing both issues. Thus, government policy will need to become increasingly prescriptive regarding collaboration. However, the government must first decide what *future* capabilities are important to its national security. Finally, chapter 7 offers some final thoughts as well as conclusions based on the study's analysis of NAO data.

Two key themes run through this paper: the first is that the self-interest of states is the driving force in sovereignty. It is this self-interest that undermines any attempt to achieve affordability through collaboration. The second is the central importance of technology to equipment development. Ultimately, although collaboration may provide an effective means of enhancing a nation's operational advantage, it has significant limitations as a strategic tool for managing both short- and long-term affordability challenges.

As noted, sovereignty in equipment procurement is a complex issue. Modern weapon systems employing a "system of systems" approach to engineering means that tracing any dependencies on foreign support can be difficult and open to interpretation. Using top-level data as presented in the NAO MPRs—the primary sources for this paper—makes identifying which category of sovereignty an equipment program falls into sometimes problematic. Therefore, for the purpose of analysis here, sovereign projects are defined as those that,

in principle, appear to be capable of being developed and operated free from the external constraints of other nations. The author fully accepts, and expects, project specialists to draw alternative conclusions for their respective projects; such is the complexity of sovereignty.

Finally, as mentioned previously, financial data from NAO-generated MPRs form the backbone of this paper. Although data provided covers a period of 15 years and captures the delivery performance of 58 projects totaling £90 billion of approved investment, in statistical terms this data pool is still relatively limited and specific to the United Kingdom. The projects that the NAO selects to feature in the MPRs are those that dominate Ministry of Defence (MOD) equipment expenditure. Accordingly, they constitute a skewed—but nevertheless important—sample featuring the most complex and expensive projects.[4] The conclusions identified in this paper therefore cannot be interpreted as statistically significant and should be used only as a framework for consideration in future procurement activities.

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

1. *Concise Oxford English Dictionary*, s.v. "sovereignty."
2. Cox with Sinclair, *Approaches to World Order*, 306.
3. Ministry of Defence, "First Rivet Joint Aircraft Delivered"; and Drury, "Spy Planes Cannot Refuel."
4. Kirkpatrick, "MoD Major Project Reports," 102.

Chapter 2

Sovereignty—Theory

Theory then becomes a guide to anyone who wants to learn about war from books; it will light his way, ease his progress, train his judgment, and help him to avoid pitfalls.

—Carl von Clausewitz
On War

Sovereignty is the authority of a state to govern itself—the ability to operate free from external control. To understand the role of sovereignty in the procurement of military equipment, it is first necessary to understand the portrayal of sovereignty within the context of international relations. The paradigms of international relations are both numerous and varied in their context, each likely to provide a different perspective of the problem. The international order is typically expressed in two ways: importance of power and importance of institutions.[1] Therefore, for the purpose of this study, the two contrasting theories of neorealism and economic liberalism were selected. Examining sovereignty through the perspective of these two prominent theories facilitates understanding not only its relationship to national power but also the risks and benefits of the alternative strategy, collaboration.

The Realist Position

Realists assume that anarchy—the absence of a centralized world authority—is the overarching constraint of world politics and that power is essential to the creation and sustainment of order. Order can take the form of a balance of power, where the counterbalance of opposing state powers serves as a restraint and equilibrium of power is a source of stability, or of hegemony, where unrestrained preponderance of power provides stability.[2]

In *War and Change in World Politics*, Robert Gilpin defines *power* as the economic, military, and technological capability of a state.[3] He argues that while "economic growth and demographic change are the most important forces underlying international political change," frequently "the triggering mechanism for change may be the major technological, military or economic changes that promise significant gains to a particular state or major losses to other states in the international system."[4] Technological and military changes

manifest themselves in the ability of a nation to deliver operational advantage and superior military technology.

John Mearsheimer also highlights the relevance of technology to the power of the state. He observes that "great powers not only seek to imitate successful practices, they also prize innovation. States look for new ways to gain advantage over opponents, by developing new weapons, innovative doctrine, or clever strategy." However, as Mearsheimer observes, any advantage through technology will be temporal in nature because "states do not acquire new technologies simultaneously, which means that the innovator often gains significant, albeit temporary, advantages over the laggard."[5]

Realists view international politics as a zero-sum game; one nation's gain is another nation's loss. With this in mind, a realist considers collaboration in the procurement of equipment as a compromise in power. According to Kenneth Waltz, "States do not willingly place themselves in situations of increased dependence. In a self-help system, considerations of security subordinate economic gain to political interest."[6] In practice, interdependence in equipment procurement manifests itself in heightened risks in both the short and long term. In the short term, realist concerns include the following questions: (1) In a world of joint supply chains, is a state's ability to operate the equipment independently of other nations reduced? (2) Do increases in the number of procuring nations correspond to reduced agility in development of equipment? (3) How are variations in nations' requirements resolved? Furthermore, the loss of both technical and industrial support bases—one of the short-term cost benefits of collaboration—means that reverting to a sovereign option in the longer term is made increasingly unaffordable. The validity of these concerns is addressed in the next chapter.

Despite these risks, a realist does not think that collaboration should be avoided at all costs. For example, Waltz argues that a sovereign state "decide[s] for itself how it will cope with its internal and external problems, including whether or not to seek assistance from others, and in doing so limits its freedom by making commitments to them."[7] Even Machiavelli, who believed that "no reliance can be had on arms other than [one's] own," found room for collaboration. He advocated collaboration if it were in the self-interest of the state and maintained that any agreement would have no moral binding force.[8] Overall, realists perceive collaboration as both a necessary evil and a means of achieving an end.

The Liberal Position

If realists view collaboration with trepidation, for liberalists, such as Adam Smith, it serves as a guiding principle. His seminal work, *The Wealth of Nations*, codified Smith's ideas and served as a challenge to existing feudal and mercantile controls of the late eighteenth century. Mercantilists considered trading with other countries as a zero-sum game whereas Smith believed that wealth could be increased through specialization and trading. Smith's argument rested on three principles: (1) the prime psychological drive of man as an economic being is self-interest, (2) a natural order exists in the universe that makes all individual strivings for self-interest add up to a social good, and (3) the best program is to leave the economic process alone—what later became known as laissez-faire, economic liberalism, or noninterventionism.[9]

For Smith, the key to success in the industrial era was through the division of labor. Using the manufacture of steel pins as an example, he observed that, through division of labor, 10 men produced 48,000 pins in a day. In contrast, he noted that the same 10 men, individually, would not have produced 20 pins—perhaps not even 1 pin—in a day.[10] Smith attributed this quantitative improvement to increasing dexterity, saving time passing from one task to another, and inventing machinery to complete the simplified tasks.[11] However, the underlying theme to this growth in production was cooperation. Division of labor enabled each manufacturing unit to specialize but introduced dependency on other units to complete the process.

In Smith's mind, restricting cooperation to the domestic market served as restraint on the free market, something he vehemently opposed.[12] As he states in *The Wealth of Nations*, "The general industry of a country . . . is certainly not employed to the greatest advantage, when it is thus directed towards an object that it can buy cheaper than it can make." However, although Smith advocated for an international free market, he did concede that defense was an area where protection of domestic industry was acceptable.[13] Smith's latitude for defense was based on his view that "the first duty of the sovereign, that of protecting the society from the violence and invasion of other independent societies, can be performed only by means of a military force."[14]

Smith also acknowledged that the sovereign's principal duty is a costly business, both in times of war and peace, with technology being one of the major cost drivers.[15] In the late eighteenth century, Smith regarded the introduction of gunpowder as a technology capable of delivering operational advantage between nations. The advantage came at a financial cost, but he believed that it was a cost worth paying: "In modern war the great expence of fire-arms gives an evident advantage which can best afford that expence."[16]

David Ricardo identified further benefits of cooperation in the early nineteenth century in his opposition to the Corn Laws, tariffs designed to protect the United Kingdom's corn manufacturing. In his argument, he formulated the idea that there can be mutual benefit from international trade. He argued that a nation should concentrate on sectors where it had a comparative advantage: the ability to produce one thing at a lower cost than that of producing another. By specializing in their comparative strengths, trading nations are better able to improve on their collective benefit than if they were to operate individually.[17] Nations would be at liberty to release limited resources, thereby allowing for the collective production of more profitable goods. This argument holds even if one party has an absolute advantage over all of its trading counterparts.

The potential benefits offered by a liberal market are, however, somewhat restricted by the potentially unique characteristics of the defense market. A monopoly exists when a single seller attains "exclusive possession or control of the supply or trade in a commodity or service."[18] Monopolies tend to lead to markets typified by a lack of economic competition to produce goods or services and a lack of viable alternatives. The polar opposite of a monopoly is a monopsony—a "market situation in which there is only one buyer" who can interface with numerous providers and thereby dictate the market conditions.[19] Individually, both monopolies and monopsonies are rare. However, in the UK defense industry they exist in tandem, thereby further skewing the market away from the theoretical model (see chap. 4). While liberalists espouse the benefits of collaboration, they also recognize that the uniqueness of defense procurement may act to limit them.

The Academic Position

The concept of equipment collaboration has been subject to limited academic research catalyzed on an intermittent basis by NATO conferences. In his review of the development of the international system, Aaron Cowley suggests that diminishing sovereignty was part of the natural evolution of the international order.[20] Cowley reasons that the ability to recognize the value of cooperation and employ it robustly ranked among the most valuable traits of the human species. Further, human social structures evolved over time to help ensure survival and meet other needs. Nevertheless, he also notes that the benefits motivating long-term cooperation are often undermined by the temptation of defection for short-term gains: "Nations often select the bird in hand over two in the bush."[21] As Cowley indicates, the European Union (EU)

may have been conceived at the Treaty of Westphalia, but it took the painful experiences of the Thirty Years' War and the two world wars to mature to its present, still incomplete form. The message is simple: nation-states are driven by self-interest, and any compromise in sovereignty is likely to be a product of a significant strategic shock as opposed to any voluntary concession. Many academics believe that resource pressures imposed on defense spending may provide such a shock for the provision of military equipment. The impact of the reduction in defense spending from the perspective of procurers and manufacturers is discussed next.

In his appraisal of the EU approach to military collaboration, Tomáš Valášek states that—barring a few minor military expeditions—no EU government has gone into a "shooting war alone" since the United Kingdom fought Argentina in 1982.[22] As the tonic to offset decades of inadequate European defense budgets, he identifies pooling and sharing; cooperating more closely across borders in the form of common maintenance, training, and education; sharing infrastructure; and creating joint units. He also stresses that European advances in collaboration have been episodic: "For each partnership many more countries have opted to go it alone, because they fear that they may not be able to deploy their shared units, or because they worry about the costs."[23] Furthermore, savings through specialization, such as the Estonian effort to coordinate NATO's studying of cyber threats, is largely negated by the desire of many governments to retain or develop a national capacity.[24]

The struggle to retain national capacity also resonates in Thomas Overhage's analysis of European military capabilities. In the wake of the 2010 banking crisis and the Libyan campaign in 2011, Overhage describes nations being caught by a "defense interest trilemma" in which security, sovereignty, and resource efficiency each receive differing emphasis as a result of overriding national, political, and strategic culture. He argues that domestic pressures, such as the media, lead to a "short term, emotional, reactive definition of national interest." As a result, nations like France and the United Kingdom seek to "to preserve the full range of military capabilities" while retaining the ability to "conduct combat operations at a time and place of national choosing."[25] Additionally, as each nation struggled to restructure its military following the 2010 banking crisis, it was evident that cost savings were very much sought at a national level and did not reflect wider European coordination or cooperation.[26]

Giovanni Faleg and Alessandro Giovannini observe that a lack of coordination had extended to the European defense market, which they viewed as being characterized by the presence of a multitude of national industries, each with its own forms of protection and related national interests.[27] They point

out that "member states usually design procurement specifications with the implicit purpose to contract national defence manufacturing industries, and maintain in this way the complete sovereign control of the national knowledge in defence production."[28] Faleg and Giovannini conclude that as emerging nations seek to turn their economic strengths into a force-projection capacity, collaboration might be essential if defense industries are to remain competitive. Their recommendations take three forms: first, expanding the collaboration shown in the air and space sector to the land and maritime domains; second, agreeing on long-term strategic priorities for collaborative groups to focus research and development (R&D); and finally, following Ricardo's theory of mutual gains through specialization leading to more efficient, cost-effective, and better integrated militaries. In reality, as Cowley suggests and as chapter 4 indicates, the temptation of nations to exploit short-term gains and their reticence to concede sovereignty often undermine such mitigations.

International relations theorists agree that sovereignty in defense procurement is a necessary component of national power and something that should be retained—but not at any cost. Recent academic research on the procurement of military equipment generally supports collaboration—perceived as a potential remedy to the paradoxical stranglehold of spiraling equipment costs and dwindling defense budgets. The cost of such a strategy, however, is the sacrifice of sovereignty. By promoting greater interdependence, nations attempt to address short-term affordability issues at the expense of long-term independence.

Chapter 3 reviews the United Kingdom's procurement policy for major military equipment over the past 15 years. Analysis addresses whether the United Kingdom is following the evolutionary cycle described by Cowley and whether recent financial constraints have created sufficient shock to trigger increased collaboration, as other academics suggest.

Notes

1. Ikenberry, *After Victory*, 10.
2. Ibid., 24.
3. Gilpin, *War and Change*, 13.
4. Ibid., 55.
5. Mearsheimer, *Great Power Politics*, 163, 231.
6. Waltz, *Theory of International Politics*, 107.
7. Ibid., 96.
8. Machiavelli, *Art of War*; and Nardin and Mapel, *Traditions of International Ethics*, 68.
9. Smith, *Wealth of Nations*, viii.
10. Ibid., 5.
11. Ibid., 7.

12. Henderson, *Concise Encyclopedia of Economics*, s.v. "Adam Smith," 591.
13. Smith, *Wealth of Nations*, 424, 429.
14. Ibid., 653.
15. Ibid., 668.
16. Ibid., 669.
17. Henderson, *Concise Encyclopedia of Economics*, s.v. "David Ricardo."
18. *Concise Oxford English Dictionary Online*, s.v. "monopoly," accessed 24 February 2016, http://www.oxforddictionaries.com/us/definition/american_english/monopoly.
19. Ibid.
20. Cowley, "Evolution of the International System," 3.
21. Ibid., 117.
22. Valášek, *Surviving Austerity*, 1.
23. Ibid., 8.
24. Ibid., 40.
25. Overhage, *Less Is More*, 19, 58, 63.
26. Ibid., 62.
27. Faleg and Giovannini, *Pooling and Sharing*, 11.
28. Ibid., 13.

Chapter 3

Sovereignty—Policy

Over the past two decades, the key policy directives regarding UK equipment sovereignty and collaboration were the 1991 NAO-sponsored report *Ministry of Defence: Collaborative Projects*; the 2005 *Defence Industrial Strategy* (*DIS*) white paper; and the 2012 *National Security through Technology* white paper. The MOD's performance in executing these policies can be measured through the MPRs presented to Parliament annually. The reports detail cost and time performance of the largest defense projects that the department has chosen to invest in. The United Kingdom's approach to sovereignty over past decades in terms of policy and practice is described next.

Ministry of Defence: Collaborative Projects

Published in February 1991, the NAO-sponsored report on the MOD's collaborative projects examined the approach toward equipment collaboration based on the leading 10 collaborative projects.[1] Regarding collaboration and the widening opportunities for purchasing from overseas, the report detailed three key findings that were to feature prominently in equipment procurement over the coming decades.

First, subject to an overall policy of obtaining maximum value for money spent, the report expected "most significant new equipment developments to be collaborative." The NAO identified the following potential advantages offered by collaborative projects: cost savings compared to national alternatives, interoperability with allies, and in-service support savings through centralized spares holdings.[2] Disadvantages identified included the effect of collaborative factors manifesting in the delay of project timescales, issues with the reconciliation of cost/work share with national objectives, constraints placed on the nation's freedom to withdraw, and the impact of withdrawal by other nations.[3] Simply put, the report forecast increasing tension in the role of sovereignty: operational advantage—access to cutting-edge equipment and technology—would necessitate increased interdependence with other nations.

Second, after reviewing project performance from 1984 to 1988, the NAO concluded that a lack of common equipment requirements and timescales created difficulties for collaboration.[4] Furthermore, the report highlighted considerable differences in the collaborative expenditure of each operating environment. Whereas the air environment appeared to embrace partnership

with other nations by apportioning approximately one-third of its budget to collaborative projects, both land and maritime environments were more reticent—each apportioning less than 5 percent of its expenditure to cooperative projects. The prime reason cited for the difference in approach to collaboration was air's propensity for having "more expensive and technologically complex equipment where development costs account for a relatively high proportion of total procurement costs."[5] Thus, this 1991 report portrayed collaboration as an unfavorable strategy that both maritime and land components could afford to avoid due to their relatively low project costs.

Finally, and perhaps most importantly, NAO analysis suggested that collaboration yielded higher production costs than those of sovereign projects.[6] The NAO acknowledged that this conclusion was somewhat unexpected as one of the key assumptions of collaboration is its reduction of costs through shared nonrecurring costs and economies of increased scale in production. It pinpointed numerous projects where the benefits of increased scale were undermined by disparate national strategies, such as standardization of equipment and in-service support.[7] Despite this observation, the NAO generally supported collaborative projects because it expected increases in production costs to be offset by savings generated by collaborative R&D.[8] Giovannini and Faleg echo this view in their report on the future of the European defense market.[9] The NAO noted some significant limitations that national policies placed on collaboration and indicated the difficulties that would need to be addressed if it were to achieve its full potential. In essence, the NAO had observed that sovereignty was stopping the full benefits of collaboration from being realized.

Defence Industrial Strategy White Paper

In 2005 the United Kingdom issued the *DIS* white paper identifying future defense requirements and, for the first time, detailing the industrial capabilities needed to ensure that equipment could be operated in a manner consistent with national choosing.[10] Sovereignty represented one of three strategic themes in the *DIS*, which identified a direct link between the through-life sovereignty of military equipment and national security. The *DIS* prescribed measures to protect all phases of development—from R&D, through manufacture, to the retention of test and evaluation capability—for every sovereign industrial sector. The strategy aimed for the UK government to work with its onshore industry to develop an affordable, competitive, and sustainable industrial base.[11]

The *DIS* was not, however, simply a protectionist measure to support all UK industry. Instead, it introduced the term *appropriate sovereignty*, defined as "the appropriate degree of sovereignty over industrial skills, capacities, capabilities and technology to ensure operational independence against the range of operations that [the United Kingdom] wish[es] to be able to conduct." For example, the *DIS* rejected previous directives that the United Kingdom retain an absolute sovereign capability to build warship hulls onshore, but it recognized the need to retain some capability to maintain competence in warship design, integration, and development.[12] In essence, the *DIS* acknowledged the increased benefits of global competition but also directed governmental intervention to prevent the disappearance of indigenous capabilities required to maintain national security. It represented the government's clear statement regarding its limits for conceding national sovereignty.

National Security through Technology White Paper

In February 2012, the MOD released its *National Security through Technology* white paper establishing the procurement policy for defense and security needs to meet the vision of *Future Force 2020*.[13] In replacing the *DIS* as a policy document, the white paper represented a significant shift in government policy for equipment sovereignty. If sovereignty were a focal feature of *DIS*, it was conspicuous by its relative absence. The white paper in effect signaled a move away from prescriptive measures to protect sovereignty. One possible cause for this policy shift was the emphasis placed on the newly elected coalition government that debt reduction was the national security priority. The coalition government implemented a reduction in defense spending of 12.24 percent in real terms from 2008 to 2015.[14]

The government acknowledged concerns about the policy change but argued that "at a time of constrained budgets and unpredictability of threat," it was appropriate to clarify the "understanding of what operational advantages and freedom of action [the government] need[s] to protect."[15] Whereas the *DIS* directed detailed activities for each industrial sector to protect sovereignty, the white paper simply presented a broader list of concepts that could be traded upon at risk. The United Kingdom's position on the sovereignty of military equipment was now open to interpretation.

The white paper introduced two means of defining sovereignty: freedom of action and operational advantage. *Freedom of action* was defined as "the ability to determine internal and external affairs and act in the country's interests free from intervention by other states or entities, in accordance with [its] legal

obligations." While this definition may not have differed greatly from the views offered by theorists such as Machiavelli or Adam Smith, the white paper did introduce a key caveat. Despite freedom of action being essential to national sovereignty, it would not be bought "at any cost." *Operational advantage* was defined as "the ability to find and maintain an edge over potential adversaries."[16] The white paper identified long-term investment as key to obtaining, and maintaining, operational advantage involving military equipment and technology. In a world of finite resources and rapidly evolving threats, the need for long-term investment presented the United Kingdom with a particularly challenging strategic choice: in which capability area should it invest?

The white paper listed four broad capability areas where sovereignty would be protected. The first situation involves any capability considered fundamental to the freedom of action of the nation—for example, cryptography. A second case occurs when a supplier might need access to classified material—for instance, a provider of support to the propulsion and weapon system of the United Kingdom's national deterrent. The third circumstance takes place if the capability were considered essential to deliver an assured capability to respond—for example, the ability to maintain and update defensive aid suites at a sufficiently responsive tempo to support military operations. Finally, sovereignty would be protected for a capability considered key to delivering operational advantage, therefore requiring a high confidence in performance. The need to protect sovereignty in critical situations ultimately meant investing in personnel to maintain subject-matter expertise to retain the United Kingdom's position as an intelligent customer.

The white paper's reduced prominence of sovereignty contrasted with a corresponding heightened stress on collaboration. The document advocated bilateral collaboration for offering "the best balance of advantages and disadvantages." The United Kingdom also committed to wider European and NATO collaborative efforts, in particular NATO's Smart Defence initiative emphasizing pooling and sharing to fill key capability gaps.[17] This dramatic shift in emphasis can be traced to perhaps the key theme in the white paper: affordability.

At the time of issuing the white paper, the UK government was confronted with the major challenge of delivering an affordable strategy for national security. Despite having, at the time, the fourth largest defense budget in the world, the UK government still considered it insufficient means to face an increasingly capable and diverse range of threats.[18] In response, the United Kingdom promoted a more liberal approach to defense procurement: using

the open competition of the global defense market to obtain "products that are proven, that are reliable, and that meet our *current* needs" (emphasis added).[19]

The "new approach" to procurement directed by the white paper placed primacy on COTS products while protection of sovereignty was relegated to the final consideration. From a policy standpoint, the United Kingdom adopted an increasingly liberal position and, in line with the academic analysis, sought to balance the "potential benefits of taking a particular acquisition approach for a specific defence or security capability against the possible risks to [its] freedom of action."[20] The question remains, however, whether collaboration is the proverbial "maiden's prayer" or is more a case of achieving short-term savings at the expense of long-term security. Chapter 4 compares the recent UK experience with collaborative versus sovereign projects in an effort to identify if collaboration is really an affordable alternative to sovereignty.

Notes

1. Great Britain National Audit Office, *Collaborative Projects*.
2. Ibid., 1, 13.
3. Ibid., 13.
4. Ibid., 9.
5. Ibid., 8.
6. Ibid., 13.
7. Ibid., 15.
8. Ibid., 1–13.
9. Faleg and Giovannini, *Pooling and Sharing*.
10. Great Britain Ministry of Defence, *Defence Industrial Strategy*, 2.
11. Ibid.
12. Ibid., 17, 70.
13. Ibid., 5.
14. Great Britain Ministry of Defence, Joint Concept Note 3/12, *Air Space Operating Concept*, 1–8.
15. Great Britain Ministry of Defence, *National Security through Technology*, 6.
16. Ibid., 26.
17. Ibid., 8, 32.
18. Ibid., 8.
19. Ibid., 6.
20. Ibid., 27.

Chapter 4

Sovereignty—Analysis

The primary source of evidence used in this paper to determine the performance of equipment projects is the National Audit Office's annual major projects reports. The NAO is independent of the British government and is responsible to Parliament, under the direction of the comptroller and auditor general, for the scrutiny of public spending. The comptroller and auditor general have statutory authority to report to Parliament on whether departments have used their resources effectively, efficiently, and with economy. Each year they present to Parliament data on the cost, time frame, and performance of the 16 largest (by cost) defense projects in which the MOD has chosen to invest. They are known as post-main-gate projects, and the data is presented in the form of an MPR.[1]

Although the MPR is only a snapshot of the major projects, Parliament considers the volume of expenditure sufficient to serve as a reliable indicator of wider performance of MOD procurement. For example, the *MPR 2012* accounted for £19.5 billion of equipment procurement and served as a foundational document for assuring Parliament of the MOD's ability to "balance prudent financial management with meeting the capability needs of the armed forces."[2]

In compiling the MPR, project managers submit a project summary sheet (PSS) detailing the performance of the project during the previous reporting period. Data included in the PSS includes the original approval for the project in terms of both cost and time and the forecast for the project entering into service as defined by the in-service date (ISD). The ISD is normally a point at which the Front Line Command accepts that the equipment is capable of meeting the majority of key user requirements. Comparing these values makes it possible to determine changes to both the cost and time performance for each project.

Categorization

The PSS also has a summary of the project procurement route. For the purpose of this paper, these summaries are used to categorize the level of sovereignty attributed to the project. Analysis of the PSSs shows that equipment procurement may be categorized in four ways, which in decreasing levels of

sovereignty are sovereign procurement, collaborative development, COTS, and pooling and sharing.

Sovereign procurement enables the United Kingdom to exploit its own technology and resources to design, manufacture, and maintain equipment. In theory, these conditions allow it to both operate autonomously of other nations' approvals and have the technological and industrial infrastructure to develop any follow-on program. In practice, where a system-of-systems approach is used to deliver highly complex military weapon capability, it is very difficult to determine whether a system has some reliance on a foreign entity at a subcomponent level. For example, consider the procurement of six Type 45 destroyers. The Type 45 was designed, manufactured, and operated as a sovereign asset, but its Principal Anti-Air Missile System (PAAMS) is a collaborative project with France and Italy. For the purpose of this analysis, sovereign projects are judged as those *intended* to be developed and operated free from the external constraints of other nations. In the instance of the Type 45, according to this definition, it is judged to be a sovereign platform despite the presence of the PAAMS.

Under collaborative development, the United Kingdom acts in partnership with other nations to design and manufacture equipment while each procuring nation continues to meet maintenance costs. As reflected in the 1991 NAO review on collaboration, sharing of the design and development processes necessitates an alignment of capability requirements among the procuring nations.[3] Any compromise in capability requirements needed to produce a consensus can be construed as a reduction in operational advantage and therefore a reduction in sovereignty. UK involvement in the Eurofighter/Typhoon program is an example of collaborative development.

COTS acquisition sees the procuring nation divorce itself from the design and development phase of the project to decrease delivery times and increase cost efficiency. COTS procurement has been used increasingly over recent years, particularly in meeting deliveries against urgent operational requirements for Iraq and Afghanistan. The United Kingdom's procurement of C-17 transport aircraft from the United States is an example of COTS procurement. The categorization of COTS includes the procurement of existing equipment that is modified, prior to entering service, to meet specific capability requirements. For example, the Panther command and liaison vehicle is based on an Italian Iveco-designed vehicle and was subsequently upgraded to UK specifications by BAE Land Systems.[4]

Pooling and sharing occurs when the dependency for the delivery of the capability is transferred completely to another country or organization in return for either funds or alternative capability. Elements of pooling and sharing are present in collaborative development as well as in COTS procurement—the resources of other nations may be used in both the design and development phases of manufacture. For the purpose of this paper, pooling and sharing is defined as the provision of full military capability in lieu of financial contributions. Although no projects were listed as pooling and sharing in the *MPR 2012*, in chapter 5 the NATO collaborative procurement of Global Hawk is used as a mechanism to identify some of the benefits and issues surrounding this type of procurement. A full list of the categorizations applied to each project is detailed in appendix A.

Performance

Next, we consider whether the United Kingdom's defense procurement has followed, in practice, the policy changes described in the last chapter. To make this determination, we initially examine the differences between sovereign and collaborative projects in two ways. First, the variation between forecast and actual expenditure is compared with corresponding observations made in a 1991 NAO audit on collaborative projects. Thereafter, the variation in the total number of sovereign and collaborative projects detailed in MPRs from 1999 to 2013 is analyzed. Comparing these sets of data enables identifying a potential disconnect between the United Kingdom's policy and the procurement practice surrounding sovereignty.

Using the categorization described previously, it is possible to determine the variation in approved expenditure between sovereign and collaborative projects. Data detailing the variation in expenditure is detailed in appendix A and summarized in figure 1.[5] During the period 1999–2013, collaborative expenditure outweighed its sovereign counterpart by a ratio of two to one. A similar comparison, conducted by the NAO in 1991, determined that this ratio was previously three to one in favor of sovereign expenditure, suggesting a marked shift toward collaborative procurement over the past 15 years. Such a conclusion, particularly when placed in the context of increasing fiscal pressure on defense expenditure, appears supportive of academic theories that collaboration is a safe port in times of fiscal austerity. However, increasing the granularity of analysis to consider defense procurement at the environmental levels of air, land, and maritime reveals other factors at work.

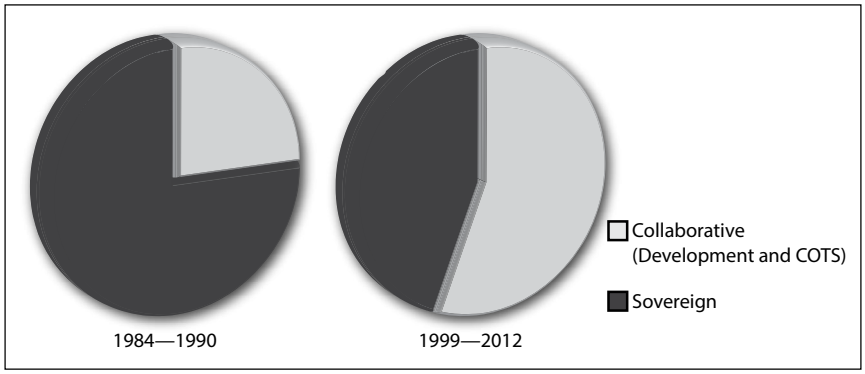

Figure 1. Apportionment of defense expenditure: sovereignty versus collaboration

Data detailing the distribution of expenditure by operating environment for the period 1999–2013 is detailed in appendix B. As summarized in figure 2, procurements in the air domain accounted for 94 percent of all approved collaborative expenditure. In contrast, only one maritime collaborative investment—the procurement of extremely high frequency / superhigh frequency satellite communication terminals for selected submarines at an approved cost of £290 million—featured in the MPRs during the period. Similarly, in 1991 the NAO highlighted disparities in the approach each operating environment took toward collaboration: in 1987 air systems accounted for 95 percent of all collaborative expenditure while collaborative investment in sea systems was reported to be "very low."[6]

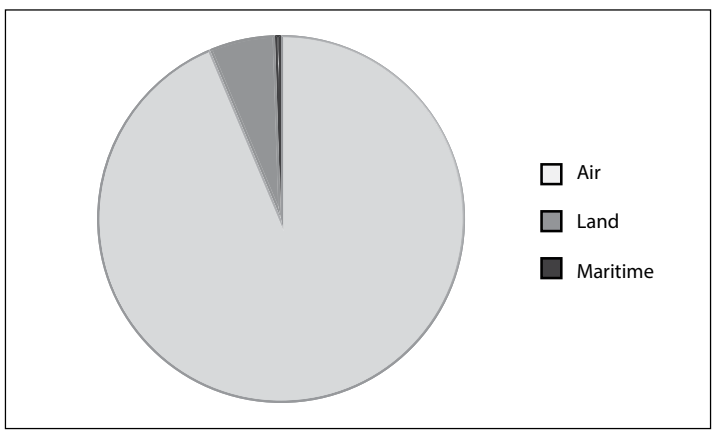

Figure 2. Collaborative projects: distribution of expenditure by operating environment, 1999–2013

Analysis by operating environment expenditure appears to counter the conclusion that a shift toward collaboration has occurred and suggests that in over two decades very little has changed for the United Kingdom in terms of the application of collaborative strategies. That is, the air domain remains positive in its approach to collaboration while land and maritime domains remain reticent. Resolving this apparent conflict in conclusions requires introduction of a third comparison: the variation in total numbers of sovereign and collaborative projects.

Analyzing approaches to procurement through apportionment of expenditure alone may introduce a form of selection bias. Military procurement, in particular for the air environment, is dominated by high-unit-value specialist projects. Inclusion of a few relatively high-cost projects in the data, such as the Typhoon and Joint Strike Fighter—both of which occur during the period—may obscure any trends offered by more numerous, yet relatively cheaper, projects. The variation in numbers of collaborative and sovereign projects is considered to address this potential bias. Although such data was not available for the period from 1984 to 1990, it is possible to trace fluctuations in procurement practices from 1999 to 2013. While such analysis is not supported by sufficient data to be statistically significant—the number of projects represented in each MPR is limited to approximately 16—it does offer an alternative insight into trends during the period.

Figure 3 illustrates the variation in the numbers of sovereign and collaborative projects featured in MPRs from 1999 to 2013. It also depicts the variation in defense expenditure over the same period. A steady increase in expenditure, attributed to commitment to campaigns in Afghanistan and Iraq, is marked by a significant decline following the release of the House of Commons Defence Committee's *Strategic Defence and Security Review* (*SDSR*) in 2010.[7]

Figure 3 also shows that the number of sovereign projects featured in the MPR each year varied between 7 and 13 during the period, reaching its apogee in 2007. By contrast, the number of collaborative projects varied between 5 and 9 and never exceeded that of their sovereign counterparts. Interpreting the data across the period makes it possible to conclude that the average number of sovereign and collaborative projects remained steady at 10 and 7, respectively. These trends further support the assertion that little has changed in the United Kingdom's approach to sovereignty when investing in military equipment. If true, this assertion raises two further questions: (1) Why has the promise of increased collaboration not been realized? (2) Why does the apportionment of military expenditure suggest otherwise (see fig. 1)? Three possible factors can be used to explain these apparent anomalies.

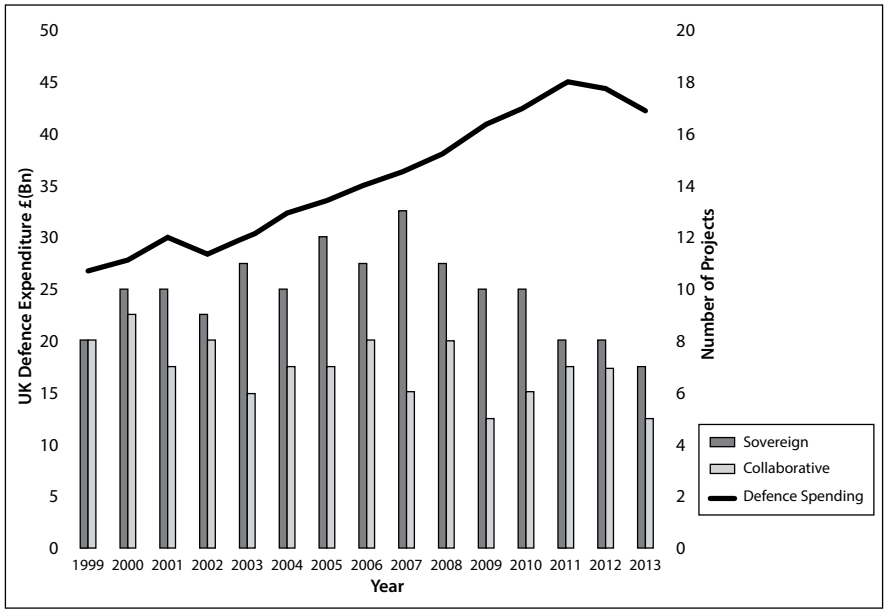

Figure 3. Variation in defense expenditure and sovereign/collaborative projects

First, collaboration opportunities may simply not have arisen. As the NAO noted in 1991, sovereign equipment requirements need to align with those of other nations for collaboration to occur. Further, as the Type 45 case study (chap. 5) highlights, opportunities that do arise are usually undercut by misaligned national capability requirements, spending limitations, and workshare agreements. Second, the effect of reduced defense spending may not yet have been manifested in procurement trends. The average procurement period for the *MPR 2012* projects was 10 years.[8] Therefore, current reporting may partially reflect a legacy approach toward sovereignty. In this instance, the relative shift toward collaboration shown from 2009 could be interpreted as the beginning of a long-term trend. This explanation is, however, undermined by the fact that a similar pattern of change also occurred between 2003 and 2006; furthermore, this shift predates both the cost cuts of the 2010 *SDSR* and the 2011 *National Security through Technology* white paper. Finally, a high level of investment in air platforms—such as Typhoon, Rivet Joint, A-400M, and the Future Strategic Tanker—occurs during the period of analysis.

Considering all these factors, this paper maintains that the shifting expenditure merely reflects a relatively high investment in air platforms during the

period (fig. 1). By extension, it concludes that, despite marked changes in policy in 2005 and 2013, the United Kingdom's approach to collaboration has not changed accordingly.

Why has there been such resistance to exploiting the perceived benefits of collaboration? One answer could be legacy institutional bias against the compromise of state sovereignty at the project level. For example, realizing the full cost benefits of collaboration would require closing state infrastructure, such as shipyards. In terms of sovereignty, such drastic measures would take generations to redress. Of note, nowhere in the data analyzed was a sovereign project initiated to replace a capability previously provided by collaboration. An alternative motive could be that the perceived cost benefits attributed to collaborative projects have simply not materialized. In 1991 the NAO hinted that the cost benefits of collaboration might not be as clear-cut as intuition would suggest.[9] These theories are examined next through comparing the cost and time performance of collaborative and sovereign projects.

Cost

The through-life variation of project costs was compared by using PSS data. A detailed breakdown of project costs is presented in appendix A. Figure 4 shows the variation of percentage project costs according to class of sovereignty as defined earlier in this chapter. The cost approvals featured in the PSSs range from £17 billion (Eurofighter/Typhoon) to £200 million (Soothsayer). Therefore, percentage costs, in terms of initial approval versus final delivery cost, have been used in an attempt to normalize the total cost variations. Analysis of the data in figure 4 provides two differing conclusions regarding the influence that sovereignty and collaboration have on project costs.

First, 15 of the 31 sovereign projects analyzed experienced some form of cost growth during their manufacture. On average, this cost growth translated into an increase in sovereign project costs of 5 percent over their initial approvals. Furthermore, sovereign projects exhibited a trend of year-on-year cost growth, particularly in the lead-up to a capability entering service. In some cases—particularly for larger sovereign projects—these incremental increases manifested into significant, almost unbounded cumulative cost growth. Procurement of the *Astute*-class nuclear submarines and *Queen Elizabeth*–class aircraft carriers provides such an example: project costs exceeded 50 percent of their original funding approval. Conversely, of the 16 sovereign projects delivered under budget, the majority produced savings of less than 5 percent. Only the contracts to provide precision-guided bombs and a land-support

vehicle were delivered for more than 20 percent below the expenditure initially approved. In both instances, the savings were a result of MOD departmental program management as opposed to efficiencies of the projects.

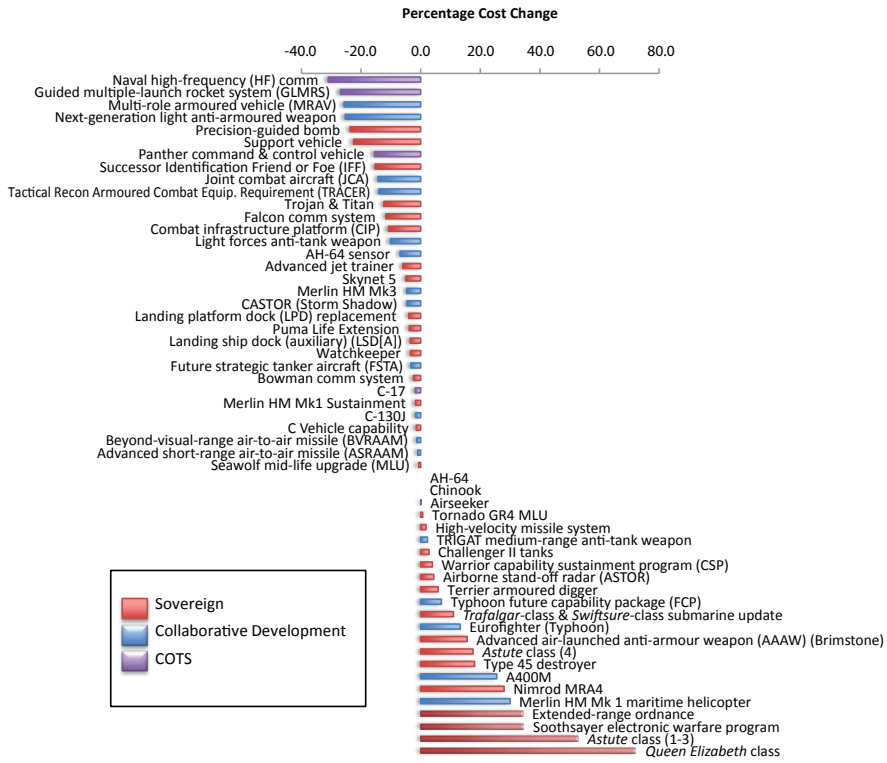

Figure 4. Cost performance: percentage cost change

Second, compared to the cost performance of their sovereign counterparts, that of collaborative projects was more stable in terms of both net performance and profile. Of the 22 collaborative projects observed, only 5 were delivered for a cost greater than their initial approval—all of which were collaborative development. Collaborative projects, on average, completed delivery of their equipment into service at a cost of 5 percent less than their initial approval; COTS projects in particular showed a propensity for delivering on budget (fig. 4). Furthermore, in general, collaborative projects did not

exhibit the gradual, and in some cases unbounded, increase in costs that featured significantly in the sovereign projects.

There are, however, some exceptions to the observation that collaborative projects helped bound cost growth. Indeed, in some instances, the cost performance of collaborative development projects bore remarkable similarities to their sovereign counterparts. Of the five projects that experienced cost growth, two of them (Airbus A400M Atlas transport aircraft and Merlin HM Mk1 maritime helicopter) grew in excess of 30 percent. While data availability precludes analysis of Merlin HM Mk1 project profiles, the A400M experienced a 34 percent increase in cost over a four-year period—an experience mirroring the sovereign submarine and aircraft carrier projects.

Analysis of cost performance suggests two key benefits for collaborative projects. First, collaboration appears to bound total costs. Over the period, a 10 percent net difference occurred in the cost performance of collaborative projects over that of their sovereign counterparts. Second, in general, collaborative projects exhibited a fairly steady cost profile throughout the manufacturing period. The *MPR 2012* noted that changing cost profiles created "turbulence and uncertainty for the Equipment Plan, reducing the [MOD's] ability to plan and manage the defence budget effectively."[10] Therefore, the stable cost profiles shown by collaborative projects should support capability planning. Although these findings appear to support the academic premise that collaboration is an effective cost-saving measure, the evidence presented shows that this rule is not absolute. The performance of the A400M demonstrated that collaboration does not guarantee a project's protection from the spiraling cost increases observed in some sovereign projects. Furthermore, comparing projects against their ISDs reveals a less favorable record of collaborative projects.

Time

For the purpose of this paper, ISD is the parameter used for measuring the time performance of equipment programs. A summary of the variation between the ISD initially forecast and that actually achieved is presented in figure 5. The overriding impression of that figure is similarity in the timeliness of sovereign and collaborative projects. Both experienced significant delays in delivering equipment, with sovereign and collaborative projects suffering average delays of 22 and 17 months, respectively.

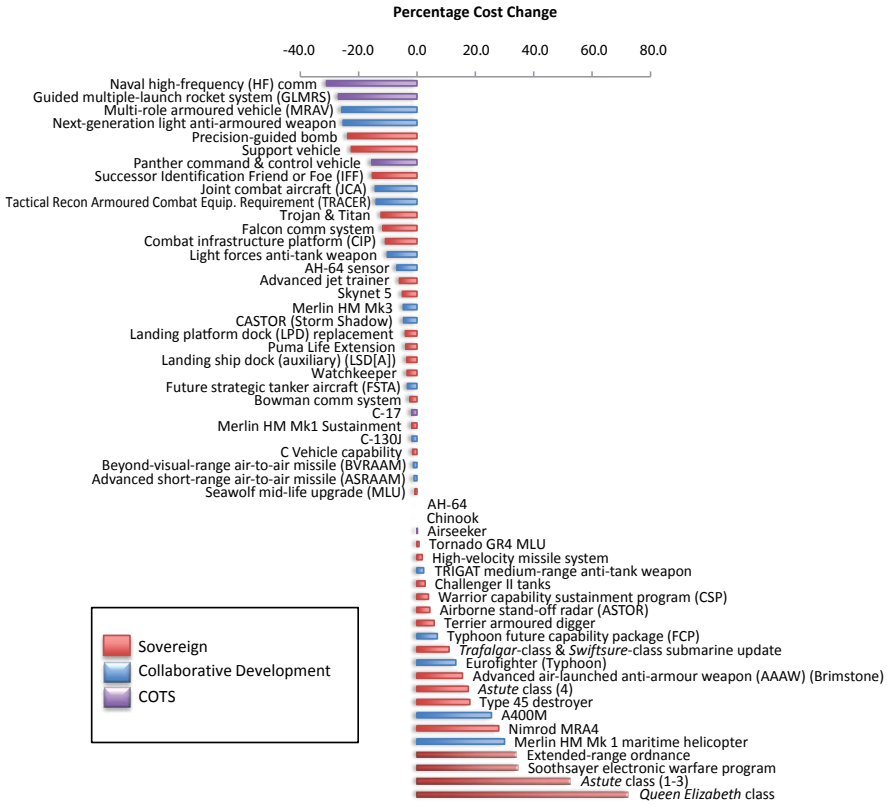

Figure 5. Time performance: variation in ISD by project

Sovereign projects delivered early were outnumbered by a ratio of two to one against those delivered late. Furthermore, at least five projects—including the later-cancelled Nimrod MRA4 Maritime patrol and attack aircraft—experienced delays in excess of three years. In a similar comparison, collaborative projects fared little better; again, there were more late than early deliveries—12 to 5, respectively. Four projects—including the subsequently cancelled TRIGAT medium-range anti-tank weapon—incurred delays in excess of three years. As with cost performance, COTS procurements tended to be delivered according to schedule. Chapter 5 provides some balance to the generally favorable view of COTS presented so far by highlighting the political limitations of such an approach.

One discrepancy in the perceived similarities in time performance between sovereign and collaborative projects lies in the associated costs and management of any delays. When equipment is delivered late, the MOD is generally forced to accept a capability risk associated with retaining older equipment in service to cover for the delay to new equipment. In some instances, additional costs are incurred for updating existing equipment to extend its service life. A 2009 Royal United Services Institute (RUSI) report highlights MOD inconsistencies in reporting secondary costs such as erosion of operational benefit, added costs of continuing to operate predecessor equipment, and disrupted manpower and training. The report went so far as to state that "some MOD project offices virtually ignore the financial and operational penalties of delay."[11] As a specific example, the RUSI speculates that because Typhoon's out-of-service date was dictated by its predicted obsolescence against hostile air defense systems, its loss in operational benefit due to a four-and-a-half-year delay could be as much as £4.5 billion.[12]

Fully quantifying the operational costs of delayed projects would be difficult and arguably unreasonable. However, it is important to recognize that the sovereign state must meet the cost of any delays. Although such costs apply equally to sovereign and collaborative projects, the effects of delays are more acute for collaborative ventures: the nature of collaboration means that the needs of the group predominate. Any attempt to mitigate secondary costs through normal project management techniques, such as reducing the delay by trading capability, is dependent on an alignment of the collaborative partner's interests.

The increased delays of collaborative projects are likely to manifest in associated costs that will be met by each sovereign partner. To understand the rationale for these delays and identify whether they serve as a delineating factor between sovereign and collaborative projects, one finds it instructive to investigate the causal factors listed in the PSSs.

Causal Factors

The PSSs categorize the key casual factors for changes in cost and time performance in terms of corporate and project changes. Corporate changes can be either new capability requirements due to revised MOD needs flowing from operational assessment or new budgetary guidelines based on updated departmental budgetary priorities. Project changes are categorized into (1) technical factors, which affect the technical ability to deliver the project; (2) procure-

ment processes, which affect contractual procedures, including those for collaborative projects; and (3) contracting processes (introduced in 2009), which affect contract negotiations.[13]

Details of the causal factors affecting all MPR projects for the period 1999–2013 are provided in appendix C. Figure 6 summarizes the total number of such factors for changes in project cost and time performance. Discussed next is the influence of these causal factors on these projects from corporate and project perspectives.

From the corporate viewpoint, projects can be managed externally by manipulating capability requirements or budgetary inputs. Inspection of figure 6 reveals that corporate changes were directed more toward implementing cost changes than schedule changes. During the period 1999–2013, 121 corporate changes were implemented to manage cost versus only 23 to manage time. Averaging changes against the number of projects indicates that approximately 60 percent of the changes were made in collaborative projects. This finding addresses two myths surrounding collaboration. First, industry favors collaboration because the difficulties of aligning group interests effectively lock in governments to defined requirements and avoid capability creep. Second, and in some ways related, collaboration restricts the role of the sovereign nation in the management of projects. Figure 6 refutes both of these charges and, if anything, indicates that governments may be expected to exercise more corporate control over collaborative projects than do their sovereign counterparts.

Project-driven causal factors that influence changes in cost and time performance include technical factors, procurement processes, and contract processes. Of these factors, as well as those for corporate-driven change, the technical aspect predominates (fig. 6). Unlike corporate changes, technical factors influenced both cost and time performance, with 128 and 55 changes, respectively. Both from a cost and time perspective, technical factors adversely affected sovereign projects about twice as much as their collaborative counterparts. A secondary factor affecting project changes is procedural. Perhaps counterintuitively, figure 6 indicates that little differentiates the programmatic changes attributed to the procedural processes of either sovereign or collaborative projects.

Examining the project performance of recent major MOD military procurements has identified several conceptual themes. First, the issue of sovereignty and collaboration is more complex than may appear at first glance. In the paradigm of military equipment procurement, shades of sovereignty exist whereby gradual increases in collaboration are paid for by a reduction in

sovereignty. In decreasing levels of sovereignty, the procurement processes identified are sovereign procurement, collaborative development, COTS, and pooling and sharing.

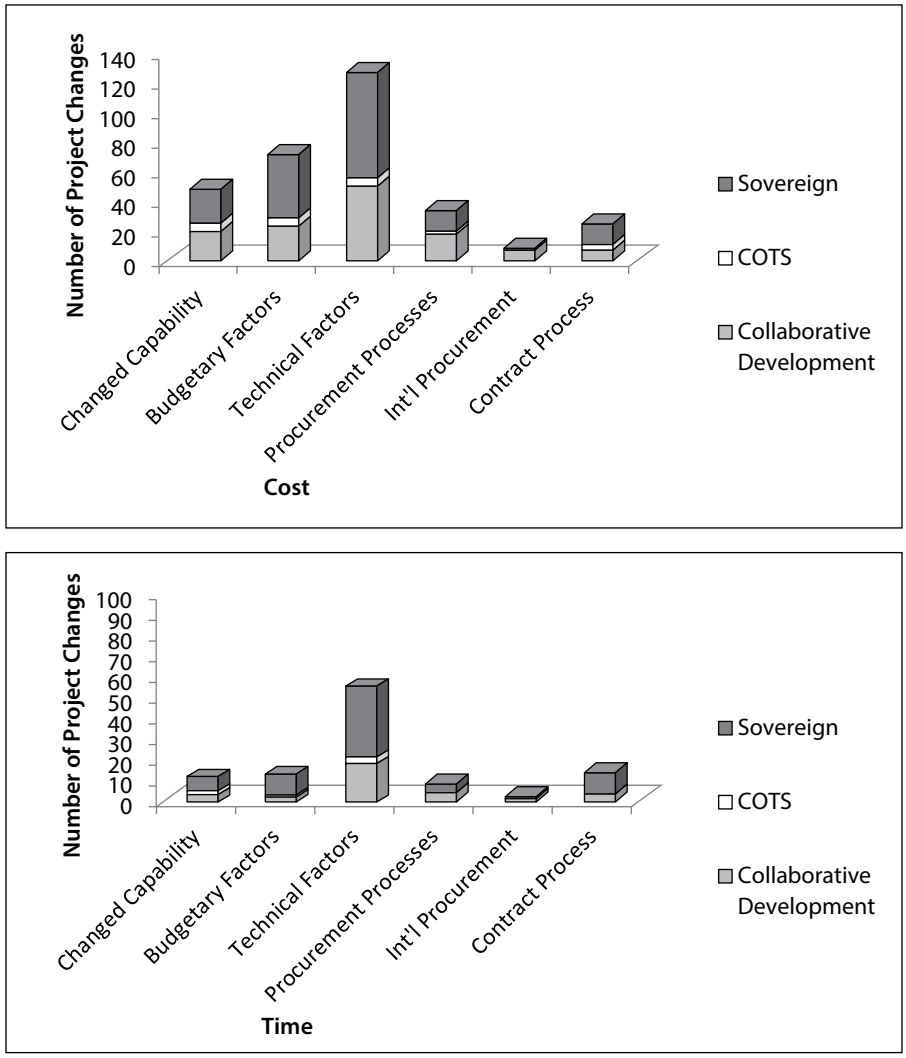

Figure 6. Causal factors for cost and time performance changes (total)

Second, tracing key policy documents makes it possible to discern a distinct shift in the United Kingdom's approach toward sovereignty and collaboration. In the early 1990s, at the birth of the European Union, the United Kingdom appeared hesitant, almost cautious, about the opportunities offered by collaboration. By 2013 a far more liberal approach had been adopted, and collaboration was seen almost as a cornerstone of policy. The reason for the change was the increasingly technologically complex nature of defense projects, making them increasingly unaffordable within a sovereign capacity. Overall, technical factors appear to be the main impediment, regardless of sovereignty status, in delivering projects within time and cost constraints.

Third, it appears that very little has changed regarding each operational environment's approach to sovereignty, with air being pro-collaboration and land and maritime remaining bastions of sovereignty.

Finally, supporting the theoretical and political promise of increased affordability, economies of scale leveraged by collaboration generally provide savings. However, there is no guarantee. Evidence shows that collaborative projects are equally susceptible to the almost unbounded cost growth, as are their sovereign counterparts. In practice, from the perspective of cost and time performance, little differentiates sovereign and collaborative projects. Equally, fears that increased collaboration may reduce a country's sovereign input into the management of projects appear unfounded. These themes are developed next through the use of case studies.

Notes

1. Great Britain National Audit Office, *Major Projects Report 2012*, 1.
2. Ibid., 5.
3. Great Britain National Audit Office, *Collaborative Projects*, 15.
4. Great Britain National Audit Office, *Major Projects Report 2006*, 93.
5. Great Britain National Audit Office, *Collaborative Projects*, 7.
6. Ibid., 8.
7. Chantrill, "Time Series Chart."
8. Great Britain National Audit Office, *Major Projects Report 2012*, 4.
9. Great Britain National Audit Office, *Collaborative Projects*, 19.
10. Great Britain National Audit Office, *Major Projects Report 2012*, 7.
11. Kirkpatrick, "MoD Major Project Reports," 105.
12. Ibid.
13. Great Britain National Audit Office, *Major Projects Report 2012*, 12.

Chapter 5

The Application of Sovereignty

In this chapter, four case studies highlight and develop some of the issues realized in recent sovereign and collaborative projects. The first case is the United Kingdom's sovereign procurement of the Type 45 destroyer. It illustrates the conflict between a nation's need to deliver operational advantage through state-of-the-art military equipment and the practical demand to spread the associated high development costs across collaborative partnerships. The second is the European collaborative development of the Eurofighter/Typhoon fourth-generation fighter. Again, the project suffered major issues with aligning interests, resulting in numerous cost increases and time delays. However, when one considers the fighter project in the long term, the United Kingdom gained a high-end technological capability beyond the national means to deliver.

The third case study concerns the Danish COTS procurement of precision munitions. While the United Kingdom's experience of COTS procurement has been generally favorable, this example highlights the potential implications of total dependency on another state for a capability. The final case study presents the NATO procurement of Global Hawk unmanned aerial vehicles to bolster its intelligence, surveillance, and reconnaissance (ISR) capabilities—a program that the United Kingdom has opted to contribute to via its sovereign Sentinel wide-area surveillance program rather than financial investment. The study emphasizes the susceptibility of a collaborative project to the external influences of states pursuing national self-interest.

Type 45 Case Study: Sovereignty

In July 2000, UK defense ministers approved the £5 billion procurement of 6, out of a planned class of 12, Type 45 destroyers as a replacement for the aging Type 42 destroyers.[1] Although at the time of approval it was estimated that the first ship would enter service in November 2007, the in-service date was not until July 2010.

Since the 1980s, the United Kingdom had been involved in three separate projects to replace its Type 42 destroyers. The first attempt, a collaborative project called NATO Frigate Replacement for the 1990s, involved the United Kingdom, the United States, Canada, France, Germany, Italy, Spain, and the Netherlands. Differing national requirements, spending limitations, and timescales

made consensus impossible, and the project was cancelled in 1989.[2] In 1992 another collaborative project, known as Horizon, was initiated among the United Kingdom, France, and Italy to produce a ship and its weapon system, the PAAMS. Again, national requirements plagued the collaboration, and in 1999 the United Kingdom withdrew from Horizon because "costs were unacceptable . . . and industry could not agree [on] a Prime Contractor Framework."[3] Although the United Kingdom withdrew from Horizon, it continued to collaborate with the French and Italians in developing the PAAMS that would be later integrated onto the Type 45. Rather than buying a modified variant of America's multirole DDG-51 *Arleigh Burke*–class destroyer, whose costs and performance were stable, the United Kingdom had opted to develop its own anti-air-warfare destroyer in an attempt to improve on its high-end sovereign capabilities.[4]

Withdrawal from Horizon meant an extension to the increasingly obsolescent Type 42 destroyers. The MOD estimated the cost of extending the Type 42s to be £195 million, the bulk of which was associated with manpower, spares, and equipment.[5] The cost of extending the Type 42s would have exceeded £400 million if the Royal Navy had not accepted a reduction in availability and readiness levels by retiring ships early. By mid-2007 Type 42 availability had fallen below 50 percent.[6] The repeated failure of collaborative efforts to deliver operational advantage resulted in fewer ships at sea, equating in turn to a reduction in sovereign freedom of maneuver.

In 2004 the Type 45 project was experiencing substantial time and cost delays. To manage costs, the government decided to reduce the fleet size from 12 ships to 6. It also declined an option in 2008 to procure 2 more ships. Although exercising this style of aggressive project management may not have been feasible in a collaborative program, it still failed to deliver the savings envisioned. NAO analysis concluded that the sovereign construction of a Type 45, excluding development costs, was broadly in line with other types of destroyers of a similar class.[7] However, if development costs were included, the cost of the Type 45 was over £100 million more per ship than its class counterparts.[8] Because the MOD had reduced the number of ships ordered to half that originally envisioned, extensive development costs, such as the integration of PAAMS, were not spread as widely as expected.

In 2009 the House of Commons Public Accounts Committee was highly critical of the Type 45 project taking over 20 years to deliver a replacement for the Type 42. Furthermore, it summarized the strategy for mitigating the ensuing capability shortfalls as one of "juggle and hope."[9] While the situation may have been born from the failings of collaboration, the Type 45 case study illustrates a key theme of this paper: the constant friction between a nation's

need to deliver state-of-the-art military equipment and the institutional reticence to spread the associated high development costs across collaborative partnerships.

Eurofighter/Typhoon Case Study: Collaborative Development

When the Eurofighter entered service with the RAF, it was given the name Typhoon. This decision in itself raised objections with its German collaborators due to connotations of the successes of a similarly named aircraft interdicting German forces in World War II. Both the Eurofighter and Typhoon titles are used interchangeably throughout this paper, depending on the context.

When conceived in the late 1980s, the Eurofighter project was the poster child of European interdependence. Collaboration among the United Kingdom, Germany, Italy, and Spain meant that the Eurofighter could draw upon the specialization of each nation's air and space and defense industries. According to the 2011 NAO report *Management of the Typhoon Project*, "The main aim of collaboration was to reduce the cost to each partner nation in designing, producing, and supporting a highly complex and technologically advanced new aircraft."[10] Certainly, the United Kingdom's perspective was that the capability could not be delivered in an efficient and affordable manner without collaboration, which offered a means of increasing the operational advantage of all partner nations.

While Adam Smith advocated for the invisible hand of market forces to guide the shape of such collaboration, work-share arrangements for the Eurofighter project were driven more by political considerations than commercial or military imperatives. The result of this compromise was to affect national sovereignty in two major ways. First, the operational advantage of the project was diminished as partner nations failed to agree on long-term capability requirements. As a 2011 report from the House of Commons Committee of Public Accounts observed, "The collaborative arrangements have proved problematic. The spread of design, manufacturing and support expertise across a number of suppliers throughout Europe has increased the cost of the aircraft overall and poses risks to the timeliness and affordability of support and upgrade activities."[11] Second, on occasion, the collaborative equipment support contract limited the freedom of maneuver of the Typhoon capability. For example, in 2008 only 70 percent of requested equipment spares had been delivered by the required deadline to support an operational deployment. The net result was that the remaining aircraft in the fleet were scavenged for parts.

Overall, the NAO estimated that shortfalls in the collaborative process used to deliver the Typhoon resulted in a cost increase of approximately £2.2 billion.[12]

With these difficulties in mind, it would be easy to dismiss collaboration as failing to deliver on its promise of affordability. However, a political desire to retain a sovereign industrial base drove inefficiencies into the collaboration. The 2011 NAO report also pointed out that "Typhoon contracts [were] negotiated with United Kingdom industry on a non-competitive basis under long-standing agreements which enable industry to recover agreed overhead costs."[13] Following the 2010 *Strategic Defense and Security Review*, the accelerated retirement and drawdown of the Harrier and Tornado fleets, respectively, resulted in a forecast reduction in industrial demand. Due to the long-standing arrangements, a risk existed that unless industry restructured, "the costs of under-utilised industry assets [would] be re-charged to the [MOD] on its remaining contracts—notably Typhoon."[14] This linkage of the Typhoon project to the long-term sustainability of the UK military aircraft industry exemplifies the distorting effect that the nexus of monopoly and monopsony can generate.

One of the key concerns of entering into collaborative projects is that interdependence with other nations will impose a rigidity on the management of capabilities incompatible with the demands of operations. This fear was rebutted in chapter 4, as it is here, in light of Typhoon's deployment to support coalition operations in Libya in 2011. Software for the Typhoon aircraft radar and defensive aid systems was quickly updated to ensure the protection of aircraft and aircrew.[15] Furthermore, within a matter of days, the United Kingdom, on its first operational deployment of Typhoon beyond its defensive counterair role at home and in the Falklands, was able to accelerate delivery of the aircraft's nascent air-to-ground capability.[16]

Although the Typhoon case study illustrates some of the pitfalls of collaborative development, it can also be interpreted as an exemplar of how collaboration can work. The Eurofighter project delivered a technologically advanced capability that was both beyond the means of national resources and responsive to the needs of the nation—qualities to which any sovereign capability would aspire.

Denmark Case Study: Commercial Off-the-Shelf

As described in chapter 4, the United Kingdom's experience of procuring COTS military equipment has been relatively successful during the period of analysis. In response to urgent operational requirements for Iraq and Afghanistan, COTS is a proven procurement route that is both agile to a nation's

requirements—assuming that the desired capability exists and is available—and predictable in terms of cost and time performance. However, as argued previously, COTS is a short-term intervention; any savings in R&D and manufacture will ultimately undermine the domestic industrial base and thereby erode any ability to deliver operational advantage in the long term. Furthermore, as this case study shows, dependency directly correlates with increased political risk. Denmark's shortage of COTS munitions during the NATO campaign in Libya highlights another shortfall of COTS procurement: the dangers of dependency when sovereign demand exceeds the capacity of foreign supply.

In a display of overwhelming national support, Denmark deployed six F-16s in March 2011 to support NATO operations in Libya. In their description of Denmark's involvement in the campaign, Peter Jakobsen and Karsten Møller describe the "Danish Way of War" as founded on the premise of collaboration and a "willingness to let its principal allies decide where, when and how force will be used." From a strategic perspective, Jakobsen argues, Denmark's aim "is not to win wars or even battles but to support the right cause and the right allies in order to gain goodwill, prestige, security and influence."[17] It is a policy that has a certain resonance with the *National Security through Technology* white paper. Over the last 15 years, Jakobsen asserts, the pedigree of Denmark has risen to compete with that of the United Kingdom as the United States' staunchest ally. From the equipment perspective, Denmark has effectively offset the components of sovereignty, prioritizing operational advantage at the expense of freedom of maneuver.

In Libya—as in other recent conflicts in Bosnia, Kosovo, Afghanistan, and Iraq—Denmark executed its strategic role to perfection. Such was the impact of the Danish F-16s that the joint force air component commander of Operation Odyssey Dawn, Maj Gen Margaret H. Woodward, USAF, dubbed them the "rock stars of the campaign."[18] Denmark's strategy, however, had a flaw; its aircraft depended on laser-guided munitions procured via a COTS process struggling to maintain tempo with the pace of operations. By June the shortfall had become so acute that Denmark approached the Netherlands for aid.[19] However, the intensity of the air campaign, coupled with the political emphasis for no collateral damage, led to an alliance-wide accelerated depletion of precision munitions.[20] Such was the severity of the supply shortfall that Denmark was forced to look outside its normal supplier base—a move that nearly had significant political consequences.

On 10 October 2012, the Danish Defense Force accidentally released a classified post-Libya mission report to the Danish media. Included in the report were details of how the Danish Air Force had procured munitions from

Israel. The fact that the revelations were made a year after the campaign likely helped to diffuse the situation; however, they can hardly have helped Arab-Danish relations already tarnished by the publishing of cartoons of the prophet Muhammad in a Danish newspaper in 2005. Nevertheless, the revelations were a source of embarrassment for the Danish government. Given the importance of the Arab League to the campaign, similar revelations during the conflict may not have been so limited in impact. Denmark's shortfall of laser-guided bombs in Libya provides due warning that in an environment of self-interest, interdependence can be both a source of great political strength and weakness.

NATO Alliance Ground Surveillance Case Study: Pooling and Sharing

During the Chicago Summit in May 2012, NATO members agreed to the acquisition of five Global Hawks and associated ground systems under the banner of the NATO Alliance Ground Surveillance program. The aim of NATO AGS is to provide ground commanders with a persistent wide-area surveillance capability, a noted deficiency of the alliance in the Libyan campaign.[21] Valued at $1.7 billion, NATO AGS is billed as "an affordable solution during tough economic times."[22] Unable to afford this capability individually, 14 NATO nations agreed to pool resources and share what is considered an essential capability. At face value, NATO AGS appears to be an example of the pooling and sharing opportunities offered by NATO's Smart Defence concept. However, the road to NATO AGS has been far from smooth and has yet to be fully realized.

NATO AGS originated during the 1992 Defense Planning Committee; however, it was not until 2007 that the alliance achieved consensus for COTS procurement of the system, including eight air platforms. Not long after it reached this agreement, however, the defense budgets of member states came under increasing financial pressure. Citing financial reasons, Poland was the first country to withdraw from the project. Denmark and Canada soon followed Poland's lead by withdrawing in 2010 and 2011, respectively. Throughout this period, the project was confronted by a dilemma of whether to increase the costs for remaining members or to reduce capability. When Northrop Grumman submitted revised costs in 2010, NATO had downsized the number of Global Hawks it was procuring to six and later reduced the number to five.

One of the key attributes of NATO AGS is its improved affordability by accessing the wider Global Hawk market. A second concern for the project, outside the withdrawal of partner nations, has been the impact of the financial drawdown on wider Global Hawk sales. In May 2014, citing concerns over national certification, Germany cancelled its $1.3 billion acquisition of Euro Hawk, a Global Hawk variant.[23] In January 2012, the USAF declared its intent to terminate the Global Hawk program entirely.[24] Any decrease in the size of the Global Hawk market would likely be met by corresponding increases in AGS support costs. In essence, the principle of economies of scale would be working in reverse, and AGS members would be faced with footing the bill.

Both Denmark and Poland have since rejoined the project after witnessing, in Denmark's case firsthand, NATO's ISR shortcomings in Libya and reprioritizing national interests. In 2013 the US National Defense Authorization Act stipulated that the USAF "shall maintain the operational capability of each RQ-4 Global Hawk unmanned aircraft system belonging to the Air Force or delivered to the Air Force."[25] While the battle between the USAF and Congress continues, its implications, in particular regarding cost, are sure to reverberate across AGS collaborations.

Although data was unavailable for any pooling and sharing projects, analysis of NATO AGS illustrates both the strengths and weaknesses of this most extreme form of collaboration. It demonstrates that by combining their interests, 14 nations were able to procure a share in technological capabilities well beyond those expected through sovereign means.

A final issue that the AGS project raises is what happens when a member nation exercises its sovereign veto. NATO's need to gain political consensus before committing forces may dilute capabilities that are best employed, if possible, before conflicts flare up. The uncertainty engendered by this requirement may have factored in the decisions of France, the United Kingdom, and, recently, Germany to offer sovereign capabilities as "contributions in kind" versus financial contributions.[26] The presence of so-called contributions in kind may present a form of moral dilemma for the alliance; states may be more inclined to invoke their veto because there is a sovereign alternative to deploying NATO Global Hawks.

In the instance of NATO AGS, collaboration provided an opportunity for several nations to gain access to capabilities beyond their national resources. However, the cost of such an advantage is the susceptibility of a collaborative project to the external influences of states pursuing national self-interest.

A review of the preceding case studies allowed development of the three themes identified in chapter 4. First, technological complexity is making it

almost prohibitively expensive for most states to develop an operational advantage by sovereign means alone. Second, while collaborative projects may offer a viable means of sharing the burden of development, they do not guarantee against cost and time overruns. Finally, national interests such as workshare agreements and capability requirements limit realization of the full benefits of collaboration. Chapter 6 considers the implications of these themes for future procurement activities.

Notes

1. Great Britain National Audit Office, *Type 45 Destroyer*, 4.
2. Ibid., 9.
3. Ibid.
4. "DDG Type 45."
5. Great Britain National Audit Office, *Type 45 Destroyer*, 10.
6. Ibid., 11.
7. Ibid., 19.
8. Ibid.
9. Great Britain House of Commons, *Type 45 Destroyer*, Ev 12.
10. Great Britain National Audit Office, *Typhoon Project*, 8.
11. Great Britain House of Commons, *Management of the Typhoon Project*, 10.
12. Great Britain National Audit Office, *Management of the Typhoon Project*, 24.
13. Ibid., 25.
14. Ibid.
15. Great Britain Ministry of Defence, *National Security through Technology*, 24.
16. House of Commons Defence Committee, *Operations in Libya*, Ev 47.
17. Jakobsen and Møller, "Danish Way of War," 108.
18. Ibid., 114.
19. Agence France-Presse, "Danish Planes in Libya."
20. DeYoung and Jaffe, "NATO Runs Short."
21. NATO, "Alliance Ground Surveillance."
22. Michell, "NATO Alliance Ground Surveillance," 56.
23. Agence France-Presse, "Germany Axes Euro Hawk."
24. Roston, "Battle over Global Hawk."
25. Ibid.
26. Pocock, "Alternatives to Global Hawk."

Chapter 6

The Future of Sovereignty

This chapter considers the level of importance that the United Kingdom should place on sovereignty in future procurement activities. In particular, it assesses the merit of collaboration as a strategic alternative to manage affordability. First, it provides the context in which these procurement strategies will likely be employed. The focus is on two contradictory strategic drivers: economic resource and technology. Second, it recommends ways to modify current policy to maximize the benefits of both sovereignty and collaboration.

Sovereignty or Collaboration?

In late 2013, many analysts believed that the United Kingdom had weathered the worst of the financial storm and questioned what role the nation would play in the postcrash era. The *Economist* posited two scenarios: a fractured sovereign state or an enthusiastic global player.[1] In some ways, the same scenarios apply to the United Kingdom's approach to defense procurement: retention of sovereignty or a continued drift toward collaboration. One thing is certain: as "the nation [learns] to live within its means," a dramatic reversal is unlikely in the painful cost-cutting measures experienced since 2010.[2] In his analysis of the 2013 budget, the RUSI's director of UK Defence Policy Studies, Prof. Mark Chalmers, argues that "if this Government is re-elected and sticks to its commitment to continue reductions in departmental spending in 2016/17 and 2017/18, further defence cuts seem inevitable."[3] The financial squeeze, coupled with a continued flow of yet-to-be-funded major equipment programs such as the replacement for the *Vanguard*-class nuclear-powered ballistic-missile submarine and introduction of the Joint Strike Fighter, means that something will have to give.

Operational advantage through technological superiority has long been considered a foundational aspect of UK defense policy. However, as shown in chapter 4, delivering what is often highly sophisticated defense equipment within agreed costs and timescales is becoming an increasingly complex challenge. In their positioning paper *20YY: Preparing for War in the Robotic Age*, Robert Work and Shawn Brimley agree that the future battlespace will be dominated by technologies including "directed energy, electromagnetic rail guns, and high-powered microwave weapons; additive manufacturing and 3-D printing; synthetic biology; and even technologies to enhance human

performance on the battlefield."[4] The driver for these innovations is not the military sector but demands and advances in the commercial sector. Rather than dictating the pace of change, the military is increasingly a passenger riding the wave of change dictated by consumer demand. As Robert Cox observes, "In the relationship between productive and military capabilities, military demand was for a long time the stimulant of new ways of organizing production. . . . In more recent years, however, the direction of technological flow has become more ambiguous. Military innovations have become more and more dependent upon the progress of civilian technologies."[5]

The operational impact of this change in balance of investment is that civilian technology is now having a growing influence on the battlefield. As evidence, consider John Mackinlay's appraisal of the effect of the commercial communications revolution on insurgencies: "The surge of mass communications had for the first time given the insurgent the opportunity to mobilize an international array of migrant minorities and nations; there was no longer one or two populations involved but many and they were spread across the face of the globe."[6] The question remains, What role does sovereignty play in such a challenging and uncertain security environment? To answer this question, we examine the strengths and weaknesses of sovereignty and collaboration as strategic tools.

In theory, sovereignty offers a nation ultimate security, both in terms of autonomous development and employment of a capability. In practice, absolute sovereignty is a rare commodity in an environment dominated by system-of-systems architecture. In the past, the United Kingdom's sovereign efforts for capital projects have been largely directed toward the maritime environment—the production of warships, nuclear submarines, and aircraft carriers. The evidence presented in chapter 4 indicates that whatever the operating environment, sovereign investment has come at a cost. On average, sovereign projects delivered 5 percent over budget and 22 months late. Indeed, some projects, like the *Astute*-class nuclear submarines and *Queen Elizabeth*–class aircraft carriers, have experienced cost growth in excess of 50 percent and incurred delays of over three years. If these overruns resulted in enhanced national security, then one would be right to argue that it was a wise investment. However, one need only look at the important role that Scottish shipyards are playing in the Scottish devolution debate to understand that retention of a sound military industrial base is as much about domestic politics as about provision of long-term military capability. After the announcement to cease shipbuilding in Portsmouth in 2014, a well-placed source was reported as saying to the BBC that the government was "acutely conscious of the politics of the Clyde" ahead of the 2014 Scottish independence referendum.[7] The

implication was that the continued employment of the Clyde's voting shipbuilders trumped any capability considerations. Thus, politicians were concerned less with the capability provided than with where it came from and what it meant to their domestic constituents in terms of jobs.

As summarized in chapter 2, many academics see collaborative development as an antidote to the financial and technological pressures being confronted by sovereign projects. Project data supports these assumptions with, on average, collaborative projects outperforming their sovereign counterparts in terms of both cost and time performance. The evidence reviewed reveals that COTS projects in particular are able to deliver within time and cost parameters. One factor that emerged from the case studies detailed in chapter 5—but undersold by academics—is that collaboration could enhance a nation's technological advantage. In each case study—including, arguably, the sovereign project—foreign collaboration gave the United Kingdom access to technology beyond its national means.

Fears Surrounding Collaboration

Some people fear that collaboration adversely affects sovereignty by reducing a nation-state's freedom of action both politically and operationally. The evidence for such fears draws mixed conclusions. Chapter 4 rebutted the equation of collaboration with a limitation on corporate intervention. Investigation of the causal factors affecting project changes showed that a government's ability to intervene in the management of collaborative projects is no less inhibited than for sovereign projects. Evidence did, however, support the fear that collaboration impinges on a government's calculus of how and where to employ its forces in that its decisions become increasingly linked with the self-interests of other nations. In the instance of NATO's AGS system, such self-interests extend as far as determining the force strength of the capabilities being procured. Furthermore, analysis suggests that, in addition to the listed benefits, three further corrosive factors affect collaboration in defense procurement: (1) the detrimental effect of the misalignment of national interests, (2) the lag between policy and implementation, and (3) the apparent permanency of any transition from a sovereign to a collaborative approach.

First, any collaborative effort depends on the enduring alignment of national interests and long-term political investment. As each of the case studies demonstrates, alignment of requirements is inherently difficult to achieve and is continually undermined by the self-interests of states. In every case, a lack of a common equipment requirement and an agreed timescale amounted, in

effect, to the absence of a harmonized operational requirement. Although an increase in contributing nations may reduce the costs of projects, it conversely heightens the political risk. Additionally, collaboration does not always guarantee affordability. Several collaborative projects experienced the same, almost unbounded cost growth that plagued some sovereign projects. Moreover, as the Typhoon case study illustrated, the role of domestic politics and commercial factors will undoubtedly taint any national priorities.

Second, without prescriptive measures, collaboration does not appear to be a responsive mechanism for addressing funding shortfalls. Since the formation of the European Union, the United Kingdom's approach to sovereignty has ranged from the protective prescriptive measures of the 2005 *Defence Industrial Strategy* white paper to the more open laissez-faire approach of the 2012 *National Security through Technology* white paper. Yet throughout these political transitions, practical implementation has changed very little; projects continue to be assessed on a case-by-case basis.

Finally, transition from a sovereign to collaborative effort appears to be an irreversible strategy—of the 58 projects reported in MPRs from 1999 to 2013, none were a sovereign project initiated to replace a collaborative effort. The reason for this trend is that to realize the maximum financial benefits of collaboration, one must shed domestic capabilities such as industrial base and R&D expertise. This reduced industrial and R&D support makes any subsequent sovereign effort harder to justify because of the regeneration costs.

The performance of COTS illustrates the paradox facing governments when they are assessing whether to transition to a collaborative procurement approach. Chapter 4 showed that COTS by far surpassed other modes of procurement in terms of cost and time performance. This factor raises the question of whether nations should adopt a COTS-only approach to equipment procurement. The first issue is that the required equipment may not be on the shelf, resulting in a compromise of desired capability. Second, although COTS projects offer short-term benefits by exploiting economies of scale to increase cost-effectiveness, such benefits are likely made at the expense of longer-term sovereign capability. When investment is directed to foreign COTS projects, the life-sustaining long-term investment for sovereign assets is reduced. The net result is a withering of domestic capabilities such as design and manufacture, infrastructure, and specialist personnel—resources that will be prohibitively expensive, in terms of both time and finance, to regenerate.

With these factors in mind, sovereignty should not be conceded lightly, and collaboration remains a risky strategy—nations must continually consider what happens when, not if, our friends fail us.

Policy Implications

The policy implications of these observations are best understood in the context of the United Kingdom's current policy regarding sovereignty, laid out in the 2012 *National Security through Technology* white paper. That paper is built on two principles: sound R&D and a commitment to delivering operational advantage through long-term investment and access to open competition.[8] Considering these principles in light of the observations from this study makes it possible to develop recommendations for the future management of sovereign capabilities.

The white paper identifies that "technology underpins most equipment and support arrangements" and highlights long-term R&D funding as a means of meeting "an increasingly capable and diverse range of threats."[9] Despite this commitment, commercial R&D is rapidly surpassing its military counterpart. We live in exponential times when technology dictates the pace of evolution and R&D fuels the engine of change. According to investigations by Scientists for Global Responsibility, the MOD's average yearly R&D expenditure was £1.8 billion in the period 2008–11.[10] Although a significant sum, it is only half that spent by Apple and pales in comparison to Samsung's $11.2 billion and Microsoft's $10.6 billion in R&D expenditures for 2012.[11] The only way to address this yawning research gap is through effective collaboration with partner nations. Adopting the Ricardian principles of diversification and specialization will make it possible to raise the collective benefit of military R&D to meet the demands of commercial investment.

Current policy presents sovereignty as an important quality but not one to be retained at any cost. In essence, the policy seeks to adopt a principle of cost-effectiveness exercised by exposure to the free market. In some ways this policy is correct. To retain equipment sovereignty at great expense because a nation has always had such a capability would be folly. Furthermore, the nexus of spiraling defense costs and technological diversification necessitates a reevaluation of the capability areas in which a nation wishes to remain sovereign. Future policy regarding sovereignty needs to consider the shifting technological landscape and adjust accordingly. However, to make these adjustments, policy should revert to prescriptive measures that dictate areas where collaboration should occur. Collaboration in defense procurement is as much about investment of political capital to develop trust and underwrite partnerships that in all likelihood will last decades. Evidence presented in this paper suggests that without such prescriptive guidance, norms and behaviors toward sovereignty are unlikely to change rapidly. Therefore, if collaboration

is to work, the government must provide some guidance to the invisible hand of the free market.

Both of these measures seek to promote the use of collaboration to mitigate resource shortfalls and to help provide a level of capability beyond the national means. Thus, collaboration should no longer be viewed as a defensive measure—a necessary product of dwindling defense budgets—but as a potential source of strength. This strength, however, comes at a cost of increased dependence on other nations and as such carries the risk that someday another nation's self-interest may not align fully with your own.

Notes

1. "Little England or Great Britain?"
2. Ibid.
3. Chalmers, "Squeeze Continues."
4. Work and Brimley, *20YY*, 7.
5. Cox, *Approaches to World Order*, 282.
6. Mackinlay, *Insurgent Archipelago*, 79.
7. Robinson, "UK Shipyards."
8. Great Britain Ministry of Defence, *National Security through Technology*, 8.
9. Ibid.
10. Parkinson, Pace, and Webber, *Offensive Insecurity*, 6.
11. Pepitone, "Apple Spends Way Less."

Chapter 7

Conclusion

King Richard III:

What says Lord Stanley? Will he bring his power?

Messenger:

My lord, he doth deny to come.

—William Shakespeare
Richard III, Act 5, Scene 3

With these words, the balance of power at Bosworth Field shifted decisively. Lord Thomas Stanley committed his forces to the service of the House of Lancaster and Henry, Earl of Richmond. This betrayal sealed the fate of "the third sun of York." One can only imagine Richard's emotions: anger, dismay, apprehension? Whatever the emotion, it should not have been disbelief; throughout his turbulent history, Richard III had participated in a murderous game of power politics. He had witnessed his brother's rise to—and temporary removal from—the throne due to subtle shifts in the balance of power orchestrated by the scheming Earl of Warwick. Lord Thomas Stanley, a man whose family motto was *sans changer* (without changing), had achieved high office by continually ensuring that his family favored both sides during any battle. Richard's world was one of self-interest, where alliances were a source of both strength and weakness.

After his defeat, Richard was buried in a pauper's grave. The renegade Lord Thomas Stanley was appointed Earl of Derby on 27 October 1485, and the following year he was confirmed as High Constable of England and High Steward of the Duchy of Lancaster. Richard's victor, Henry, Earl of Richmond—subsequently crowned King Henry VII—would contrive his own alliances and, by uniting the houses of Lancaster and York through marriage, write a new chapter in English history.

The issues of sovereignty and collaboration remain as pertinent today as on that fateful day in 1485. This paper addressed them from the perspective of the United Kingdom's approach to procuring military equipment. Analyzing these issues through the concepts of theory, policy, and performance enabled the development of a broad understanding of the paradoxical challenges that modern governments face in the realm of equipment procurement.

Examining the issues from both the realist and liberal economist schools of thought offers a balanced view on the benefits of sovereignty and its counterpoint,

collaboration. Realists view sovereignty as an integral part of power. This view is refined by the caveat that sovereignty should not be bought at any price and that, in some instances, collaboration enhances power. The price associated with such collaboration is increased political dependency. For projects with life spans on the order of half a century, such commitment represents a significant investment of political capital.

Liberal economists present the opposite view. They believe that combining various nations' diverse and specialized strengths raises the collective level of performance. Shaping this position is the recognition that because defense is critical to a nation-state, it does not translate into a true market economy. Thus, governments are often unwilling to allow the time to let market forces do their work as doing so may court the possibility of failure. A nation-state's intervention in the collaborative process undermines the realization of its potential benefits. In essence, both realist and liberal schools of thought appear to converge on one central theme: balance is required for any approach.

In recent times, academics have tended to advocate collaboration as a means of addressing funding shortfalls. They also note that issues such as national self-interest, domestic pressures, and isolated industrial bases have, in the past, prevented nations from fully exploiting the benefits of collaboration. Such restraints were evident throughout the fiscal review and supporting case studies that this paper presented. While the academics were correct in focusing on the underexploited fiscal benefits of collaboration and the temptation of delivering capabilities beyond national resources, they perhaps underemphasized the chief drawback: risk and exposure to other nations' interests driven by increased interdependence.

From a policy perspective, the United Kingdom's approach to collaboration over the last 20 years has shifted from a means of opportunity to one of necessity. The new approach detailed in the 2012 *National Security through Technology* white paper emphasizes collaboration through bilateral arrangements and the procurement of COTS products. However, the evidence presented by this study suggests that this strategy may be a sound one in the short term but questions whether it may, in effect, be mortgaging the nation's long-term security. In essence, COTS offers short-term bridges for capability shortfalls rather than sound long-term policy. This study's analysis of NAO data from 1999 to 2013 led to three conclusions regarding cost and time performance of sovereign projects as compared to that of their collaborative counterparts.

First, despite the simplistic view portrayed by internal national groups and some newspapers, sovereignty is a complex issue. The likelihood of collaboration becomes greater, and perhaps necessary, at some level within military systems as

they continue to advance technologically. Further, operational issues such as basing rights and overflight factor into decisions leading toward collaboration versus sovereignty. Thus, absolute sovereignty is a rare commodity.

Second, collaborative—particularly COTS—projects generally outperform sovereign projects in headline costs and, to a lesser extent, time; however, this data does not present the whole picture. Limitations in reporting procedures mean that the financial costs associated with delays, which are, arguably, more acute for collaborative projects, are not normally considered at the departmental level. Thus, the financial benefit of collaboration may not be as high as the average 10 percent cost swing reported in this paper. Indeed, COTS aside, little differentiates sovereign from collaborative projects; both are equally susceptible to significant delays and almost unbounded cost growth. Use of case studies served to capture the nonfinancial costs of collaboration, especially the increased political risk and exposure to the repercussions of other nations operating in their own self-interests.

Finally, during this time frame, the air environment appeared to be much more conducive to collaboration than did the maritime environment, and, to an even greater extent, land environments, which have been far more reticent. Factors that may have influenced such approaches include the extended design and manufacture periods for the projects and the associated sovereign industrial base. Such domestic factors undermine the efficacy of collaboration as a means to combat insufficient financial resources.

Continued increases in the costs of military procurement, coupled with diversification of technologies, mean that nations face a strategic problem of the ends exceeding the means. As Ken Waltz observes, "To buy military equipment in the quantity and variety sufficient for military effectiveness exceeds the economic capability of most states."[1] If collaboration is to prove an effective tool in combating these trends, then leadership must consider two modifications to existing policy. First, to overcome the environmental reticence of both the maritime and land domains to change procurement methods, one must shift from the current laissez faire economic approach to a more prescriptive policy that details areas for collaboration. Second, a truly free-market environment, based on trust among close allies, must be established in the R&D domain. Only by accepting that the risk of sovereign failure can be mitigated by the collective benefit of collaboration can nations hope to redress the ever-increasing gap between commercial and military R&D activities.

Is collaboration an affordable strategy in times of austerity? The evidence in this paper points to a qualified yes. However, as a strategy it merely bends, but does not break, the ever-steepening equipment cost curve. For the short-term gains offered by collaboration, one must consider not only the political costs but

also what happens when opportunities for collaboration do not arise. Because of the short-term gains offered, collaboration is likely to increasingly feature the strategic landscape. The question that challenges nations in the future will not be whether to resist collaboration in favor of sovereignty but to determine *when* to collaborate and what sovereignty to invest in. In a world driven by self-interest, collaboration can be both a source of great strength and great weakness. Despite the rhetoric associated with increased military collaboration, and in spite of the economic pressures of the early twenty-first century, self-interest is still the prime motive of nation-states. Ultimately, these countries must be honest (if only to themselves) about where they wish their self-interests to take them—and then act accordingly.

Note

1. Waltz, *Theory of International Politics*, 183.

Appendix A—Project Data

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Advanced air-launched anti-armour weapon (AAAW) (Brimstone)	**2005**	Estimate £M	815	885	849	822	988	941		900	899						
		Approval	799	899	809	849	849	814		814	814						
		Difference	16	-14	-40	-27	139	127		86	85						
		ISD approval	Dec-91	Sep-01	Sep-01	Sep-01	Sep-01	Sep-01		Sep-01	Sep-01						
		Forecast ISD	Oct-01	Oct-02	Oct-02	Oct-02	Apr-04	Mar-05		Mar-05	Mar-05						
		Variation (months)	118	13	13	13	31	42		42	42						
		Type of procurement	S	S	S	S	S	S	S	S	S						
		% cost increase	2	-1.56	-4.94	-3.18	16.4	15.6		10.6	10.4						
Advanced jet trainer	**2009**	Estimate £M										467					
		Approval										497					
		Difference										-30					
		ISD approval										Feb-10					
		Forecast ISD										Nov-09					
		Variation (months)										-3					
		Type of procurement										S					
		% cost increase										-6					
Advanced short-range air-to-air missile (ASRAAM)	**2001**	Estimate £M		823	857												
		Approval		828	866												
		Difference		-5	-9												
		ISD approval		Dec-98	Dec-98												
		Forecast ISD		Dec-00	Jun-01												
		Variation (months)		24	30												
		Type of procurement		CD	CD												
		% cost increase		-0.6	-1												

CD—collaborative development; COTS—commercial off-the-shelf; ISD—in-service date; S—sovereign

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
AH-64 Apache attack helicopter	**2001**	Estimate £M	2,704	2,858	2,997	3,068	3,168										
		Approval	2,835	3,015	2,997	2,997	2,997										
		Difference	-131	-157	0	71	171										
		ISD approval	Dec-97	Dec-99	Dec-99	Dec-99	Dec-99										
		Forecast ISD	Dec-00	Dec-00	Jan-01	Jan-01	Jan-01										
		Variation (months)	36	12	13	13	13										
		Type of procurement	COTS	COTS	COTS	COTS	COTS										
		% cost increase	-4.6	-5.2	0	2.4	5.7										
AH-64 Apache attack helicopter	**2009**	Estimate £M										228					
		Approval										245					
		Difference										-17					
		ISD approval										Dec-09					
		Forecast ISD										Apr-09					
		Variation (months)										-8					
		Type of procurement										CD					
		% cost increase										-6.9					
Airborne stand-off radar (ASTOR)	**2006**	Estimate £M	14	926	930	1,013	1,002	968	954								
		Approval	13	938	938	938	938	914	914								
		Difference	1	-12	-8	75	64	54	40								
		ISD approval	Apr-03	Sep-05	Sep-05	Sep-05	Sep-05	Sep-05	Sep-05								
		Forecast ISD	Sep-05	Sep-05	Sep-05	Sep-05	Sep-05	Nov-05	Nov-06								
		Variation (months)	29	0	0	0	0	2	14								
		Type of procurement	S	S	S	S	S	S	S								
		% cost increase	7.7	-1.3	-0.9	8	6.8	5.9	4.4								

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Airbus A400M Atlas	**2015**	Estimate £M				2,356	2,484	2,619	2,644	2,616	2,629	2,632	3,285	3,231	3,105	3,268	2,809
		Approval				2,823	2,828	2,744	2,744	2,744	2,744	2,744	2,744	2,744	2,498	2,498	2,238
		Difference				-242	-344	-125	-100	-128	-115	-112	541	487	607	770	571
		ISD approval				Dec-09	Dec-09	Dec-09	Dec-09	Dec-09	Dec-09	Dec-09	Dec-09	Dec-09	Feb-09	Feb-09	Feb-09
		Forecast ISD				Jun-10	Mar-11	Mar-11	Mar-11	Mar-11	Mar-11	Dec-11	Dec-15	Mar-15	Mar-15	Mar-15	Mar-15
		Variation (months)				6	15	15	15	15	15	24	72	63	73	73	73
		Type of procurement				CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD
		% cost increase				-8.6	-12.2	-4.56	-3.64	-4.66	-4.19	-4.08	19.7	17.7	24.3	30.8	25.5
Airseeker intelligence aircraft	**2014**	Estimate £M													659	637	
		Approval													681	633	
		Difference													22	1	
		ISD approval													Oct-14	Oct-14	
		Forecast ISD													Oct-14	Oct-14	
		Variation (months)													0	0	
		Type of procurement													COTS	COTS	
		% cost increase													3.2	0.2	
***Astute*-class nuclear-powered attack submarine (1–3)**	**2010**	Estimate £M	2,012	2,768	2,698	2,707	3,710	3,484	3,492	3,656	3,798	3,806	3,933	4,041	3,480	3,386	3,414
		Approval	2,084	2,726	2,726	2,726	2,726	2,578	2,578	2,578	2,578	2,578	2,578	2,578	2,233	2,233	2,233
		Difference	-71	42	-28	-19	984	906	914	1,078	1,220	1,228	1,355	1,463	1,247	1,153	1,181
		ISD approval	Dec-01	Jun-05	Jun-05	Jun-05		Jun-05	Jun-05	Jun-05	Jun-05	Jun-05	Jun-05	Jun-05		Jun-05	Jun-05
		Forecast ISD	Jun-05	Jun-05	Jun-05	Jun-05		Jan-09	Jan-09	Dec-08	Nov-08	May-09	Mar-10	Jul-10		Apr-10	Apr-10
		Variation (months)	42	0	0	0		43	43	42	41	47	57	61		58	58
		Type of procurement	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
		% cost increase	-3.4	1.5	-1	-0.7	36.1	35.1	35.5	41.8	47.3	47.6	52.6	56.7	55.8	51.6	52.9

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
***Astute*-class nuclear-powered attack submarine (4)**	**2018**	Estimate £M											1,589	1,567	1,404	1,448	1,504
		Approval											1,610	1,610	1,279	1,279	1,279
		Difference											-21	-43	125	169	225
		ISD approval														Aug-15	Aug-15
		Forecast ISD											Dec-16	Dec-16		Jan-18	Jan-18
		Variation (months)														29	29
		Type of procurement											S	S	S	S	S
		% cost increase											-1.3	-2.7	9.8	13.2	17.6
Beyond-visual-range air-to-air missile (BVRAAM)	**2012**	Estimate £M				1,397	1,417	1,355	1,204	1,204	1,168	1,279	1,282	1,305	1,115	1,122	
		Approval				1,437	1,437	1,362	1,362	1,362	1,362	1,362	1,362	1,362	1,136	1,136	
		Difference				-40	-40	-7	-158	-158	-194	-83	-80	-57	-21	-14	
		ISD approval				Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	Aug-12	
		Forecast ISD				Jun-12	Aug-12	Aug-12	Aug-12	Aug-13	Aug-13	Aug-12	Aug-12	Aug-12	Nov-12	Nov-12	
		Variation (months)				-2	0	0	0	12	12	0	0	0	3	3	
		Type of procurement				CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	
		% cost increase				-2.8	-2.8	-0.5	-11.6	-11.6	-14.2	-6.1	-5.9	-4.2	-1.8	-1.2	
Bowman comm systems	**2004**	Estimate £M					2,023	1,991	2,007	2,017	2,009						
		Approval					2,073	2,041	2,041	2,014	2,041						
		Difference					-50	-50	-34	-24	-32						
		ISD approval					Dec-04	Dec-04	Dec-04	Dec-04	Dec-04						
		Forecast ISD					Mar-04	Mar-04	Mar-04	Mar-04	Mar-04						
		Variation (months)					-9	-9	-9	-9	-9						
		Type of procurement					S	S	S	S	S						
		% cost increase					-2.4	-2.4	-1.7	-1.2	-1.6						

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Challenger II tanks	1998	Estimate £M	2,378	2,325													
		Approval	2,312	2,203													
		Difference	65	122													
		ISD approval	Dec-95	Dec-95													
		Forecast ISD	Jun-98	Jun-98													
		Variation (months)	30	30													
		Type of procurement	S	S													
		% cost increase	2.8	5.5													
CH-47 Chinook heavy-lift helicopter	2014	Estimate £M														841	
		Approval														841	
		Difference														0	
		ISD approval														May-14	
		Forecast ISD														Nov-14	
		Variation (months)														6	
		Type of procurement														COTS	
		% cost increase														0	
Combat infrastructure platform (CIP)	2005	Estimate £M						340	338	338							
		Approval						379	379	379							
		Difference						-39	-41	-41							
		ISD approval						Dec-04	Dec-04	Dec-04							
		Forecast ISD						Jul-04	Dec-05	Dec-05							
		Variation (months)						-5	12	12							
		Type of procurement						S	S	S							
		% cost increase						-10.3	-10.8	-10.8							

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
C-130J Super Hercules transport aircraft	**2000**	Estimate £M		1,042	1,049												
		Approval		1,060	1,045												
		Difference	-14	-18	4												
		ISD approval	Jul-98	Jul-98	Jul-98												
		Forecast ISD	May-00	Jun-00	Jun-00												
		Variation (months)	22	23	23												
		Type of procurement	CD	CD	CD												
		% cost increase		-1.7	0.4												
Conventionally armed stand-off missile (CASOM) (Storm Shadow)	**2002**	Estimate £M	859	987	981	980											
		Approval	875	1,027	1,027	1,027											
		Difference	-16	-40	-46	-47											
		ISD approval	Dec-94	Aug-02	Aug-02	Dec-01											
		Forecast ISD	Dec-01	Dec-01	Dec-01	Nov-02											
		Variation (months)	84	8	8	11											
		Type of procurement	CD	CD	CD	CD											
		% cost increase	-1.8	-3.9	-4.5	-4.6											
C-17 Globemaster III transport aircraft	**2001**	Estimate £M				771	775	769									
		Approval				785	785	785									
		Difference				-14	-10	-16									
		ISD approval				Dec-01	Dec-01	Dec-01									
		Forecast ISD				Sep-01	Sep-01	Sep-01									
		Variation (months)				-3	-3	-3									
		Type of procurement				COTS	COTS	COTS									
		% cost increase				-1.8	-1.3	-2									

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
C Vehicle capability	**2006**	Estimate £M							710	703	703						
		Approval							714	714	714						
		Difference							-4	-11	-11						
		ISD approval							Apr-06	Apr-06	Apr-06						
		Forecast ISD							Mar-06	Mar-06	Mar-06						
		Variation (months)							-1	-1	-1						
		Type of procurement							S	S	S						
		% cost increase							-0.6	-1.5	-1.5						
Eurofighter (Typhoon)	**2003**	Estimate £M	14,727	18,832	18,869	18,633	19,670	19,014					17,526	20,182	17,740		
		Approval	13,356	17,364	17,364	17,364	17,364	16,671	16,671	16,671	16,671	16,671	16,671	16,671	15,173		
		Difference	1,371	1,468	1,505	1,269	2,306	2,343					855	3,511	2,567		
		ISD approval	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98	Dec-98		
		Forecast ISD	Jun-02	Jun-02	Jun-02	Jun-02	Jun-03	Jun-03	Jun-03	Jun-03	Jun-03	Jun-03	Jun-03	Jun-03	Jun-03		
		Variation (months)	42	42	42	42	54	54	54	54	54	54	54	54	54		
		Type of procurement	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD		
		% cost increase	10.3	8.5	8.7	7.3	13.3	14.1					5.1	21.1	16.9		
Extended-range ordnance	**2003**	Estimate £M			188												
		Approval			140												
		Difference			48												
		ISD approval			May-98												
		Forecast ISD			Jul-03												
		Variation (months)			62												
		Type of procurement			S												
		% cost increase			34.3												

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Falcon comm system	**2012**	Estimate £M									292	291	285	270		349	
		Approval									324	324	324	324		395	
		Difference									-32	-33	-39	-54		-46	
		ISD approval									Feb-11	Feb-11	Feb-11	Feb-11		Jun-10	
		Forecast ISD									Jun-10	Jun-10	Nov-10	Dec-10		Dec-12	
		Variation (months)									-8	-8	-3	-2		30	
		Type of procurement									S	S	S	S		S	
		% cost increase									-9.9	-10.2	-12	-16.7		-11.6	
Future strategic tanker aircraft (FSTA)	**2014**	Estimate £M												11,917	12,009	12,226	11,393
		Approval												12,536	12,307	12,307	11,779
		Difference												-619	-298	-41	-386
		ISD approval												Nov-14	May-14	May-14	May-14
		Forecast ISD												May-14	May-14	May-14	May-14
		Variation (months)												-6	0	0	0
		Type of procurement												CD	CD	CD	CD
		% cost increase												-4.9	-2.4	-0.3	-3.3
Guided multiple-launch rocket system (GMLRS)	**2007**	Estimate £M							263	263	91						
		Approval							360	360	360						
		Difference							-97	-97	-269						
		ISD approval							Jan-08	Jan-08	Jan-08						
		Forecast ISD							Apr-07	Apr-07	Mar-07						
		Variation (months)							-9	-9	-10						
		Type of procurement							COTS	COTS	COTS						
		% cost increase							-26.9	-26.9	-74.7						

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
High-velocity missile system	**2000**	Estimate £M		898	933	904	904										
		Approval		882	927	901	901										
		Difference		16	6	3	3										
		ISD approval		Sep-97	Sep-97	Sep-97	Sep-97										
		Forecast ISD		Dec-90	Dec-90	Dec-90	Dec-90										
		Variation (months)		81	81	81	81										
		Type of procurement		S	S	S	S										
		% cost increase		1.8	0.6	0.3	0.3										
Joint combat aircraft (JCA)	**N/A**	Estimate £M				2,332	2,327	2,573	1,914	1,916	1,858	1,834	1,813	2,448	2,112	2,200	2,488
		Approval				2,358	2,358	2,236	2,236	2,236	2,236	2,236	2,236	2,874	2,482	2,566	2,873
		Difference				-26	-31	337	-322	-320	-378	-402	-423	-426	-370	-366	-385
		ISD approval				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Forecast ISD				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Variation (months)				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Type of procurement				CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD	CD
		% cost increase				-1.1	-1.3	15.1	-14.4	-14.3	-16.9	-18	-18.9	-14.8	-14.9	-14.3	-13.4
Landing platform dock (LPD) replacement	**2003**	Estimate £M	635	810	786												
		Approval	619	819	819												
		Difference	16	-9	-33												
		ISD approval	Dec-00	Aug-00	Aug-00												
		Forecast ISD	Mar-03	Mar-03	Mar-03												
		Variation (months)	27	31	31												
		Type of procurement	S	S	S												
		% cost increase	2.6	-1.1	-4												

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Landing ship dock (auxiliary) LSD(A)	**2004**	Estimate £M				381											
		Approval				395											
		Difference				-14											
		ISD approval				Oct-04	Oct-04										
		Forecast ISD				Jul-04	Jul-04										
		Variation (months)				-3	-3										
		Type of procurement				S	S										
		% cost increase				-3.5											
Light forces anti-tank weapon	**2005**	Estimate £M						318	310	305							
		Approval						345	345	345							
		Difference						-27	-35	-40							
		ISD approval						Aug-06	Aug-06	Aug-06							
		Forecast ISD						Nov-05	Nov-05	Jul-05							
		Variation (months)						-9	-9	-13							
		Type of procurement						CD	CD	CD							
		% cost increase						-7.8	-10.1	-11.6							
Medium-range TRIGAT anti-tank weapon	**2005**	Estimate £M	122	941	Cancelled 31 Mar 01												
		Approval	127	920													
		Difference	-5	21													
		ISD approval	Dec-95	Dec-95													
		Forecast ISD	Jun-05	Jun-05													
		Variation (months)	114	114													
		Type of procurement	CD	CD													
		% cost increase	-3.9	2.3													

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Merlin HM Mk1 maritime helicopter	**1999**	Estimate £M	5,028	4,081	4,183												
		Approval	3,867	3,121	3,213												
		Difference	1,161	960	970												
		ISD approval	Dec-93	Dec-93													
		Forecast ISD	Mar-99	Mar-99													
		Variation (months)	63	63													
		Type of procurement	CD	CD													
		% cost increase	30	30.8													
Merlin HM Mk1 sustainment	**2014**	Estimate £M									832	832	830	829	768	791	
		Approval									840	840	840	840	805	805	
		Difference									-8	-8	-10	-11	-37	-14	
		ISD approval									Sep-14	Sep-14	Sep-14	Sep-14	Feb-14	Feb-14	
		Forecast ISD									Feb-14	Feb-14	Feb-14	Feb-14	Feb-14	Jun-14	
		Variation (months)									-7	-7	-7	-7	0	4	
		Type of procurement									S	S	S	S	S	S	
		% cost increase									-1	-1	-1.2	-1.3	-4.6	-1.7	
Merlin HM Mk3 maritime helicopter	**2000**	Estimate £M	758	752	755												
		Approval	773	789	794												
		Difference	-15	-37	-39												
		ISD approval	Dec-99	Dec-99	Dec-99												
		Forecast ISD	Jun-00	Jun-00	Jun-00												
		Variation (months)	6	6	6												
		Type of procurement	CD	CD	CD												
		% cost increase	-1.9	-4.7	-4.9												

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Multi-role armoured vehicle (MRAV)	**2008**	Estimate £M		451	335	318	With-drew 17 Jul 2003										
		Approval		428	428	428											
		Difference		23	-93	-110											
		ISD approval		Mar-11	Mar-11	Mar-11											
		Forecast ISD		Aug-08	Aug-08	Aug-08											
		Variation (months)		-31	-31	-31											
		Type of procurement		CD	CD	CD											
		% cost increase		5.4	-21.7	-25.7											
Naval high-frequency (HF) comm	**2012**	Estimate £M										200					
		Approval										290					
		Difference										-90					
		ISD approval										Nov-09					
		Forecast ISD										May-12					
		Variation (months)										30					
		Type of procurement										COTS					
		% cost increase										-31					
Next-generation light anti- armour weapon	**2009**	Estimate £M						355	356	314	318	310					
		Approval						415	415	415	415	415					
		Difference						-60	-59	-101	-97	-105					
		ISD approval						Jul-07	Jul-07	Jul-07	Jul-07	Jul-07					
		Forecast ISD						Nov-06	Nov-06	Jul-07	Jul-08	Apr-09					
		Variation (months)						-8	-8	0	12	21					
		Type of procurement						CD	CD	CD	CD	CD					
		% cost increase						-14.5	-14.2	-24.3	-23.4	-25.3					

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Nimrod MRA4 maritime patrol and attack aircraft	2012	Estimate £M	2,317	2,817	2,835	2,838	3,376	3,593	3,808	3,516	3,500	3,602		3,602			
		Approval	2,409	2,959	2,982	2,982	2,982	2,813	2,813	2,813	2,813	2,813		2,813			
		Difference	-92	-142	-147	-144	394	780	995	703	687	789		789			
		ISD approval	Dec-00	Apr-03	Apr-03	Apr-03	Apr-03	Apr-03	Apr-03	Apr-03	Apr-03	Apr-03		Apr-03			
		Forecast ISD	Mar-05	Dec-04	Dec-04	Nov-05	Mar-09	Sep-09	Sep-10	Sep-10	Sep-10	Dec-10		Oct-12			
		Variation (months)	51	20	20	31	71	77	89	89	89	92		114			
		Type of procurement	S	S	S	S	S	S	S	S	S	S		S			
		% cost increase	-3.8	-4.8	-4.9	-4.8	13.2	27.7	35.4	25	24.4	28		28			
Panther command and control vehicle	2007	Estimate £M								201							
		Approval								238							
		Difference								-37							
		ISD approval								Nov-07							
		Forecast ISD								Sep-07							
		Variation (months)								-2							
		Type of procurement								COTS							
		% cost increase								-15.5							
Precision-guided bomb	2007	Estimate £M							352	341	277						
		Approval							363	363	363						
		Difference							-11	-22	-86						
		ISD approval							Dec-07	Dec-07	Dec-07						
		Forecast ISD							Sep-07	Sep-07	Sep-07						
		Variation (months)							-3	-3	-3						
		Type of procurement							S	S	S						
		% cost increase							-3.0	-6.1	-23.7						

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Puma life extension	**2013**	Estimate £M													326		
		Approval													339		
		Difference													-13		
		ISD approval													Nov-13		
		Forecast ISD													Nov-13		
		Variation (months)													0		
		Type of procurement													S		
		% cost increase													-3.8		
***Queen Elizabeth*–class aircraft carrier**	**2017**	Estimate £M											5,133	5,900	5,131	5,348	6,102
		Approval											4,359	4,359	3,541	3,541	3,541
		Difference											744	1541	1590	1807	2561
		ISD approval											Oct-15	Oct-15	Jul-15	Jul-15	Jul-15
		Forecast ISD											May-16	May-16	Oct-16	Jul-17	Dec-17
		Variation (months)											7	7	15	24	29
		Type of procurement											S	S	S	S	S
		% cost increase											17.1	35.4	44.9	51.0	72.3
Seawolf missile system mid-life update	**2006**	Estimate £M		286	284												
		Approval		288	288												
		Difference		-2	-2												
		ISD approval		Dec-04	Dec-04												
		Forecast ISD		Mar-05	Jan-06												
		Variation (months)		3	12												
		Type of procurement		S	S												
		% cost increase		-0.7	-0.7												

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Skynet 5 military communications satellite	**2005**	Estimate £M					2,679	2,775	2,775								
		Approval					2,920	2,920	2,920								
		Difference					-241	-145	-145								
		ISD approval					Mar-05	Mar-05	Mar-05								
		Forecast ISD					Feb-05	Feb-05	Feb-05								
		Variation (months)					-1	-1	-1								
		Type of procurement					S	S	S								
		% cost increase					-8.3	-5	-5								
Soothsayer electronic warfare program	**2009**	Estimate £M									195	202					
		Approval									150	150					
		Difference									45	52					
		ISD approval									Jun-07	Jun-07					
		Forecast ISD									Feb-08	Jun-09					
		Variation (months)									8	24					
		Type of procurement									S	S					
		% cost increase									30	34.7					
Spearfish torpedo	**1994**	Estimate £M	1,810	1,348	1,347												
		Approval	1,628	1,246	1,246												
		Difference	182	102	101												
		ISD approval	Dec-87	Dec-87	Dec-87												
		Forecast ISD	Mar-94	Mar-94	Mar-94												
		Variation (months)	75	75	75												
		Type of procurement	S	S	S												
		% cost increase	11.2	8.2	8.1												

APPENDIX A

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Successor Identification Friend or Foe (IFF)	**2004**	Estimate £M				458	471	464									
		Approval				558	558	548									
		Difference				-100	-87	-84									
		ISD approval				Apr-04	Apr-04	Apr-04									
		Forecast ISD				Feb-04	Mar-04	Mar-04									
		Variation (months)				-2	-1	-1									
		Type of procurement				S	S	S									
		% cost increase				-17.9	-15.6	-15.3									
Support vehicle	**2008**	Estimate £M							1,362	1,338	1,263	1,272	1,272				
		Approval						1,641	1,641	1,641	1,641	1,641	1,641				
		Difference							-279	-303	-378	-369	-369				
		ISD approval					Apr-06	Apr-06	Apr-06	Apr-06	Apr-06	Apr-06	Apr-06				
		Forecast ISD					Apr-07	Feb-08	Feb-08	Feb-08	Feb-08	Feb-08	Jan-08				
		Variation (months)					12	22	22	22	22	22	22				
		Type of procurement					S	S	S	S	S	S	S				
		% cost increase						0	-17	-18.5	-23	-22.5	-22.5				
Terrier armoured digger	**2013**	Estimate £M							299	296	299	313	322				
		Approval							304	304	304	304	304				
		Difference							-5	-8	-5	9	18				
		ISD approval							Dec-08		Dec-08	Dec-08	Dec-08				
		Forecast ISD							Sep-08		Sep-09	Dec-11	Apr-13				
		Variation (months)							-3		9	36	52				
		Type of procurement							S	S	S	S	S				
		% cost increase							-1.6	-2.6	-1.6	3	5.9				

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Tornado GR4 mid-life upgrade (MLU)	**2012**	Estimate £M												303			
		Approval												301			
		Difference												2			
		ISD approval												Mar-13			
		Forecast ISD												Nov-12			
		Variation (months)												-4			
		Type of procurement												S			
		% cost increase												0.7			
Tactical Reconnaissance Armoured Combat Equipment Requirement (TRACER)	**2013**	Estimate £M	130	Can-celled													
		Approval	124														
		Difference	6														
		ISD approval	Dec-04														
		Forecast ISD	Oct-13														
		Variation (months)															
		Type of procurement	CD														
		% cost increase	4.8														
***Trafalgar*-class and *Swiftsure*-class submarine update**	**2004**	Estimate £M	705	669	687												
		Approval	673	619	619												
		Difference	32	50	68												
		ISD approval	Dec-98	May-02	May-02												
		Forecast ISD	May-03	May-03	May-04												
		Variation (months)	53	12	24												
		Type of procurement	S	S	S												
		% cost increase	4.8	8.1	11												

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Trojan and Titan combat engineering vehicles	**2006**	Estimate £M				357				336							
		Approval				407				398							
		Difference				-50				-62							
		ISD approval				Dec-06				Dec-06							
		Forecast ISD				Oct-05				Oct-06							
		Variation (months)				-14				-2							
		Type of procurement				S				S							
		% cost increase				-12.3				-15.6							
Type 45 destroyer	**2010**	Estimate £M				5,279	5,546		5,896	6,110	6,464	6,464	6,464	6,464	5,664	5,556	
		Approval				5,837	5,837	5474	5,474	5,475	5,475	5,475	5,475	5,475	4,757	4,757	
		Difference				-558	-291		421	635	989	989	989	989	907	799	
		ISD approval				Nov-07	Nov-07	Nov-07	Nov-07	Nov-07	Nov-07	Nov-07	Nov-07	Nov-07	May-07	May-07	
		Forecast ISD				Nov-07	Nov-07	May-09	May-09	Dec-09	Nov-10	Nov-10	Jul-10	Jul-10	Jul-10	Jul-10	
		Variation (months)				0	0	18	18	25	36	36	32	32	38	39	
		Type of procurement				S	S	S	S	S	S	S	S	S	S	S	
		% cost increase				-9.6	-5	0	7.7	11.6	18.1	18.1	18.1	18.1	19.1	16.8	
Typhoon future capability package (FCP)	**2013**	Estimate £M										436	436	445	419	441	430
		Approval										458	458	458	410	402	402
		Difference										-22	-22	-13	9	39	28
		ISD approval										Jun-12	Jun-12	Jun-12	Jun-12	Jun-12	Jun-12
		Forecast ISD										Jun-12	Jun-12	Jun-12	Jun-12	Dec-13	Dec-13
		Variation (months)										0	0	0	0	18	18
		Type of procurement										CD	CD	CD	CD	CD	CD
		% cost increase										-4.8	-4.8	-2.8	2.2	9.7	7.0

Project	ISD	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Warrior capability sustainment program (CSP)	**2018**	Estimate £M														1,319	1,371
		Approval														1,319	1,319
		Difference														0	52
		ISD approval														Nov-18	Nov-18
		Forecast ISD														Nov-18	Nov-18
		Variation (months)														0	0
		Type of procurement														S	S
		% cost increase														0	3.9
Watchkeeper unmanned aerial vehicle	**2010**	Estimate £M									901	898	895	889	839		
		Approval									920	920	920	920	847		
		Difference									-19	-22	-25	-31	-8		
		ISD approval									Feb-11	Feb-11	Feb-11	Feb-11	Jan-10		
		Forecast ISD									Jun-10	Dec-10	Dec-10	Feb-11	Jan-10		
		Variation (months)									-8	-2	-2	0	0		
		Type of procurement									S	S	S	S	S		
		% cost increase									-2.1	-2.4	-2.7	-3.4	-0.9		
Wildcat helicopter	**2014**	Estimate £M										1,911	1,669	1,689	1,644	1,663	
		Approval										1,966	1,966	1,966	1,803	1,803	
		Difference										-55	-297	-277	-159	-140	
		ISD approval										Aug-14	Aug-14	Aug-14	Jan-14	Jan-14	
		Forecast ISD										Jan-14	Jan-14	Jan-14	Jan-14	Aug-14	
		Variation (months)										-7	-7	-7	0	7	
		Type of procurement										S	S	S	S	S	
		% cost increase										-2.8	-15.1	-14.1	-8.8	-7.8	

Source: Compiled by the author from the Great Britain National Audit Office, Ministry of Defence major projects reports, 1999–2013. See bibliography for itemization of reports.

Appendix B—Environmental Cost Data

Collaborative development and commercial off-the-shelf (COTS)	Environment	Approval (£M)
Advanced short-range air-to-air missile (ASRAAM)	Air	866
AH-64 Apache attack helicopter	Air	2,997
AH-64 sensor	Air	245
Airbus A400M Atlas	Air	2,498
Airseeker intelligence aircraft	Air	633
Beyond-visual-range air-to-air missile (BVRAAM)	Air	1,136
CH-47 Chinook heavy-lift helicopter	Air	841
C-130J Super Hercules transport aircraft	Air	1,045
Conventionally armed stand-off missile (CASOM) (Storm Shadow)	Air	1,027
C-17 Globemaster III transport aircraft	Air	785
Eurofighter (Typhoon)	Air	15,173
Future strategic tanker aircraft (FSTA)	Air	12,307
Joint combat aircraft (JCA)	Air	2,566
Merlin HM Mk1 maritime helicopter	Air	3,213
Merlin HM Mk3 maritime helicopter	Air	794
Typhoon future capability package (FCP)	Air	402
Guided multiple-launch rocket system (GMLRS)	Land	360
Light forces anti-tank weapon	Land	345
Medium-range TRIGAT anti-tank weapon	Land	920
Multi-role armoured vehicle (MRAV)	Land	428
Next-generation light anti-armour weapon	Land	415
Panther command and control vehicle	Land	238
Tactical Reconnaissance Armoured Combat Equipment Requirement (TRACER)	Land	124
Naval high-frequency (HF) communications	Maritime	290

APPENDIX B

Sovereign	Environment	Approval (£M)
Advanced air-launched anti-armour weapon (AAAW) (Brimstone)	Air	814
Advanced jet trainer	Air	497
Airborne stand-off radar (ASTOR)	Air	914
High-velocity missile system	Air	901
Merlin HM Mk1 sustainment	Air	805
Nimrod MRA4 maritime patrol and attack aircraft	Air	2,813
Precision-guided bomb	Air	363
Puma life extension	Air	339
Successor Identification Friend or Foe (IFF)	Air	548
Tornado GR4 mid-life upgrade (MLU)	Air	301
Watchkeeper unmanned aerial vehicle	Air	847
Wildcat helicopter	Air	1,803
Bowman communications system	Land	2,041
C Vehicle capability	Land	714
Challenger II tanks	Land	2,203
Combat infrastructure platform (CIP)	Land	379
Extended-range ordnance	Land	140
Falcon communications system	Land	395
Soothsayer electronic warfare program	Land	150
Support vehicle	Land	1,641
Terrier armoured digger	Land	304
Trojan and Titan combat engineering vehicles	Land	398
Warrior capability sustainment program (CSP)	Land	1,319
Astute-class nuclear-powered attack submarine (1–3)	Maritime	2,233
Astute-class nuclear-powered attack submarine (4)	Maritime	1,279
Landing platform dock (LPD) replacement	Maritime	819
Landing ship dock (auxiliary) (LSD[A])	Maritime	395
Queen Elizabeth–class aircraft carrier	Maritime	3,541
Seawolf missile system mid-life update	Maritime	288
Spearfish torpedo	Maritime	1,246
Trafalgar-class and *Swiftsure*-class submarine update	Maritime	619
Type 45 destroyer	Maritime	4,757
Skynet 5 military communications satellite	Space	2,920

Source: Compiled by the author from the Great Britain National Audit Office, Ministry of Defence major projects reports, 1999–2013. See bibliography for itemization of reports.

Appendix C—Causal Factor Data

Sovereign	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process
Advanced air-launched anti-armour weapon (AAAW) (Brimstone)	1	1	2	0	0	0	1	0	1	0	0	1
Advanced jet trainer	0	0	2	0	0	1	0	0	1	0	0	0
Airborne standoff radar (ASTOR)	1	0	2	0	0	1	0	0	3	0	0	0
Astute-class nuclear-powered attack submarine (1–3)	1	3	10	1	0	0	0	0	4	0	0	0
Astute-class nuclear-powered attack submarine (4)	0	3	8	0	0	0	0	2	0	0	0	0
Bowman communications system	2	1	1	1	0	2	0	0	0	0	0	0
Challenger II tanks	1	1	0	0	0	1	0	0	1	0	0	0
Combat infrastructure platform (CIP)	0	1	4	0	0	0	0	0	3	0	0	0
C Vehicle capability	0	0	0	0	0	1	1	0	1	0	0	1

Sovereign	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process
Extended-range ordnance	0	1	1	0	0	1	0	1	1	0	0	1
Falcon communications system	2	2	2	1	0	0	1	0	5	0	0	0
High-velocity missile system	1	1	1	0	0	1	0	1	1	0	0	1
Landing platform dock (LPD) replacement	1	1	1	1	0	0	0	0	1	1	0	1
Landing ship dock (auxiliary) (LSD[A])	0	0	0	0	0	0	0	0	0	0	0	0
Merlin HM Mk1 maritime helicopter sustainment	0	0	3	1	0	0	0	0	0	0	0	0
Nimrod MRA4 maritime patrol and attack aircraft	1	1	3	0	0	1	0	1	1	0	0	0
Precision-guided bomb	1	1	1	3	0	0	0	0	0	0	0	1
Puma life extension	1	0	0	0	0	0	0	0	0	0	0	0
Queen Elizabeth–class aircraft carrier	0	7	19	2	0	0	0	3	2	0	0	0

Sovereign	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process
Skynet 5 military communications satellite	0	0	0	0	0	1	0	0	0	0	0	0
Soothsayer electronic warfare program	0	1	1	0	0	0	0	0	3	0	0	0
Successor Identification Friend or Foe (IFF)	1	0	1	1	0	1	0	0	1	0	0	1
Support vehicle	1	1	1	0	0	0	0	1	1	0	0	1
Terrier armoured digger	2	0	1	2	0	0	2	0	1	0	0	0
Trafalgar-class and *Swiftsure*-class submarine update	1	0	1	0	0	0	0	0	0	0	0	1
Trojan & Titan combat engineering vehicles	2	0	1	0	0	2	1	0	0	0	0	2
Type 45 destroyer	0	7	5	2	0	1	0	0	2	1	0	0
Warrior capability sustainment program (CSP)	2	0	1	0	0	0	0	0	0	0	0	0
Wildcat helicopter	2	12	0	0	0	0	0	0	1	2	0	0

Commercial off-the-shelf (COTS)	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process
AH-64 Apache attack helicopter	1	1	0	1	0	1	1	1	1	0	0	0
Airseeker intelligence aircraft	0	0	0	0	0	0	0	0	0	0	0	0
CH-47 Chinook heavy-lift helicopter	0	0	5	0	0	0	0	0	0	0	0	0
C-17 Globemaster III transport aircraft	1	0	0	1	0	1	0	0	0	0	0	0
Guided multiple-launch rocket system (GMLRS)	2	3	0	0	0	1	0	0	0	0	0	0
Naval high-frequency (HF) comm	1	0	1	0	0	1	0	0	2	0	0	0
Panther command and control vehicle	0	1	0	0	0	0	1	0	0	0	0	0

Collaborative development	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical Factors	Procurement processes	International procurement	Contract process
Advanced short-range air-to-air missile (ASRAAM)	1	0	1	0	0	1	1	0	1	0	0	0
AH-64 sensor	0	0	1	0	0	1	0	0	1	0		
Airbus A400M	5	1	15	6	4	0	0	0	5	1	1	0
Beyond-visual-range air-to-air missile (BVRAAM)	2	2	3	3	5	0	0	0	0	1	0	0
C-130J Super Hercules transport aircraft	1	0	1	0	0	1	0	0	1	0	0	0
Conventionally armed stand-off missile (CASOM) (Storm Shadow)	1	1	1	0	0	0	1	0	1	0	0	1
Eurofighter (Typhoon)	2	5	9	4	0	0	0	0	1	0	1	0
Future strategic tanker aircraft (FSTA)	3	5	7	1	0	0	0	0	0	0	0	0
Light forces anti-tank weapon	0	1	2	0	0	0	0	0	0	1	0	0
Medium-range TRIGAT anti-tank weapon	1	1	0	1	0	0	0	1	1	1	0	0

Collaborative development	Cost						Time					
	Corporate changes		Project changes				Corporate changes		Project changes			
	Changed capability requirements	Budgetary factors	Technical factors	Procurement processes	International procurement	Contract process	Changed capability requirements	Budgetary factors	Technical Factors	Procurement processes	International procurement	Contract process
Merlin HM Mk1	1	1	1	0	0	1	0	1	1	0	0	1
Merlin HM Mk3	1	1	1	0	0	1	0	0	1	0	0	0
Multi-role armoured vehicle (MRAV)	1	1	1	1	0	1	0	0	0	0	0	0
Next-generation light anti-armour weapon	0	3	1	2	0	1	1	0	3	0	0	0
Typhoon future capability package (FCP)	0	1	6	0	0	0	0	0	2	0	0	0

Source: Compiled by the author from the Great Britain National Audit Office, Ministry of Defence major projects reports, 1999–2013. See bibliography for itemization of reports.

Abbreviations

AGS	Alliance Ground Surveillance
COTS	commercial off-the-shelf
DIS	Defence Industrial Strategy
EU	European Union
ISD	in-service date
ISR	intelligence, surveillance, and reconnaissance
ISTAR	intelligence, surveillance, target acquisition, and reconnaissance
MOD	Ministry of Defence
MPR	major projects report
NAO	National Audit Office
NATO	North Atlantic Treaty Organization
PAAMS	Principal Anti-Air Missile System
PSS	project summary sheet
RAF	Royal Air Force
R&D	research and development
RUSI	Royal United Services Institute
SDSR	*Strategic Defence and Security Review*

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