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Offsets and the Joint Strike Fighter in the UK and the Netherlands

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Introduction: the policy issues

Defense equipment procurement policy is determined by economics and politics. The economic determinants are reflected in rising equipment costs in real terms and budget constraints. Political factors are reflected in a nation's desire for independence and its willingness to pay for such independence. As a result, nations have a set of choices about the industrial policy implications of their defense equipment procurement policy, ranging from complete independence to importing foreign equipment directly "off-the-shelf." Between these extremes, there are various international collaborative industrial policies, each involving different degrees of work sharing.

The UK has experienced all types of industrial policy in its defense equipment procurement. It has bought equipment from its own defense industrial base (e.g., ammunition, tanks, trainer aircraft, warships, submarines), it has been involved in major European collaborative programs (e.g., Jaguar, Tornado, Typhoon), and it has experienced licensed production (e.g., of US helicopters) and imports of foreign equipment, usually from the USA, with or without some form of work sharing or offset agreement (e.g., UK work share on imports of US Phantom combat aircraft and offsets on US AWACS).

For the purposes of this chapter, international collaboration is defined broadly to embrace two or more nations involved in work sharing on defense equipment procurement. This includes the traditional European collaboration where two or more nations share development costs and combine their national production orders. It also includes licensed production where a nation produces foreign equipment under licence and coproduction where nations are involved in production sharing (e.g., European purchase of US F-16 aircraft). Finally, it includes offsets associated with the import of foreign equipment (e.g., UK purchase of AWACS). In contrast, the independence associated with a nation buying from its own defense industrial base can offer the attraction of capturing all the work from the procurement.

This chapter reviews the political economy of traditional European collaborative procurement, including its inefficiencies. It then evaluates the UK involvement in the United States Joint Strike Fighter program (JSF) and reviews this as a possible model for future international collaboration. Consideration is also given to the Netherlands' procurement choice of an F-16 replacement. This decision involved the Netherlands in evaluating alternative aircraft and associated industrial participation arrangements. Both the UK and the Netherlands case studies are based on original material acquired by the author as part of an economic and industrial evaluation of procurement options. These evaluations did not involve a comparative assessment of the cost, military, and operational performance aspects of the rival aircraft. However, the case studies provide information on the industrial participation deals available for various European and US combat aircraft and are typical of such offset arrangements. They also add to our knowledge in an area that lacks published information.

UK defense procurement policy

Like all other countries, the UK is faced with the need to make defense choices in a world of uncertainty: the future and its threats are unknown and unknowable. Typically, defense input costs of both equipment and personnel (capital and labor, with the UK relying on an all-volunteer force) have risen at faster rates than any increase in the defense budget could provide for. This defense economics problem means that policymakers cannot avoid the need for difficult choices: something has to go and the question is what goes? Broadly, there are four options. First, there is the “equal misery” solution, involving less training, delays in delivery, reduced purchases of spare and replacement equipment, stretching new equipment programs and some cancellations. Second, the increased efficiency solution involves competitive procurement, purchasing from lower-cost sources overseas, smart acquisition (aiming to deliver cheaper, faster, and better equipment), and military outsourcing (including private finance initiatives and public-private partnerships). Third, the defense review solution involves a major reappraisal of a nation’s defense commitments, including withdrawal from overseas bases, the ending of major commitments, and the cancellation of some large equipment programs. The UK undertook such defense reviews following the end of the cold war (1990/91) and with its Strategic Defense Review of 1998, involving reductions in the size of the armed forces, reorganization of forces, closure of military bases, and reduced defense capability (e.g., the capability for one Gulf-type war or two Bosnia-type operations). A fourth option is to increase defense spending, but this involves sacrifices of social welfare programs. Between 1990/91 and 2000/01, UK defense expenditure declined from £30.4 billion to £24.1 billion, a reduction of some 20 percent (in constant 2001/02 prices). In contrast, over the period 2003 to 2006, UK inflation-adjusted defense spending is planned to rise by some 1.5 percent *per annum*.

Equipment is one of the major cost items in the UK defense budget, accounting for some 42 percent of expenditure in 2000/01 with personnel accounting for a further 37 percent. Given the need for difficult defense choices, the equipment procurement program is an obvious focal point for economy measures. Cheaper alternatives to “buying British” are obvious options. These include European collaborative programs and imports either with or without an offset. Alternatively, a complete program could be canceled with its associated cost savings and a reduction in UK defense capability. Options for cancellation include the UKs planned order for two new aircraft carriers, or its order for new nuclear-powered submarines, or a reduced purchase of Typhoon aircraft.

European collaboration

Typically, when the UK has purchased costly new equipment, it has chosen the European collaboration option. Examples include the Jaguar (UK-France), Tornado (UK-Germany-Italy), and Eurofighter Typhoon (UK-Germany-Italy-Spain) combat aircraft, the UK-Italian Merlin helicopter, the A400M airlifter (eight nations), and the Meteor air-to-air missile (six nations). The simple and ideal model of international collaboration offers major savings in development costs from sharing between partner nations as well as economies in production as nations combine their orders and obtain the economies of scale and learning from longer production runs. For example, two equal partners on a collaborative aircraft program would share development costs and by combining their order for, say, 200 aircraft each, they would expect savings on unit production costs of about 10 percent from a doubling of output.

Reality departs from the ideal model of collaboration. Traditionally, European collaboration has been characterized by major inefficiencies and delays reflecting work sharing and government and industrial management arrangements. Typically, each partner nation seeks a share in each sector of high technology work on a project (e.g., airframe, engine, avionics) so that work is not allocated on the basis of competition and comparative advantage. There is also duplication of flight testing centers and final assembly lines. Further inefficiency and delays arise from the complex inter-governmental committee structure and arrangements for policing and monitoring collaborative projects, all of which contribute to raising transaction costs. For example, over 75 percent of cooperative projects involving the UK required unanimous agreement from the high-level multinational Steering Committee given responsibility for the program, with each partner seeking to protect its national interests. During the early years of development of the Eurofighter Typhoon, decisions were reached through a four-level hierarchy of some 50 committees with consensus sought at each level.

> "This meant that nations did not always make decisions in an efficient and timely manner, inefficiencies which were compounded because the NATO Agency charged with managing the programme did not have clearly delegated authority and responsibility and was not a clear focus for the management of the programme. These problems were mirrored by industrial management structures which meant that responsibilities and accountabilities on both sides became blurred" (NAO, 2001, p. 34).

Inefficiency in European collaborations has been reflected in both development and production costs and in program delays. Cooperative development programs are usually more expensive than similar national projects: estimates suggest that they might be from one-third to almost twice as high as a national alternative. For example, the two-nation Merlin helicopter total development costs were estimated to be 43 percent higher than an alternative national development cost, and the corresponding figure for the four-nation Eurofighter Typhoon was an extra 96 percent. However, even with higher *total* development costs, collaboration offers savings in development costs from cost sharing with partner nations. On average, the UKs cost share is about one-third of total development costs (NAO, 2001, p. 16).

Further inefficiencies arise in collaborative production. Ideally, collaboration should lead to a 10 percent reduction in unit production costs for every doubling of output. Once again, however, collaborative production inefficiencies arise from the artificial splitting of work packages and their allocation on criteria other than minimum cost and from the establishment of multiple production lines with corresponding losses of scale and learning economies. As a result, it has been estimated that the production economies on collaborative programs are likely to be in the region of 50 percent of those on national programs (NAO, 2001, p. 17). Collaboration also leads to delays in delivery, estimated at some 11 months. Such delays have resulted from industrial factors, from the time taken for partners to commit to the project, from delays in securing funding, and from partners reducing their order quantities and withdrawing from the program (NAO, 2001, pp. 19–20; Hartley and Martin, 1993).

Initiatives have been introduced to improve the efficiency of European collaborative programs, especially their management. A four-nation procurement agency, OCCAR (France, Germany, Italy, UK), aims to improve the efficiency of European collaboration through contracts placed on the basis of competition and the rejection of traditional work sharing within individual programs *(juste retour)* in favor of global balance (national work sharing over a number of programs). Nonetheless, there will continue to be pressures from both national governments and their industries to protect their national interests (e.g., through a “Fortress Europe” policy). There will also be the continued search for cheaper defense equipment with imports being an attractive option.

UK and defense equipment imports

Since 1980, UK defense equipment imports have shown a rising trend in both levels and shares of total UK equipment spending. Aerospace imports from NATO countries, especially the USA, have dominated the import figures (see table 8.1). Such imports have been at the expense of the UK defense industrial base and have also been reflected in UK requirements for offsets for its domestic industry.

Offsets appear attractive but appearances can be deceptive. Questions arise as to how much of any offset is genuinely new business which would not otherwise have been obtained, how much is high technology work, how much is defense-related business, how much involves highly paid jobs, whether the offset work is temporary or permanent, and whether extra costs are involed ved. UK experience with the purchase of Boeing AWACS aircraft for the RAF illustrates some of the problems with offsets. For this purchase, the UK agreed a 130 percent offset. However, Boeing was allowed to count its purchase of Rolls Royce civil aero-engines for its commercial aircraft as part of the offset obligation. This meant that civil aerospace work was counted against a defense offset commitment. The arrangement was generous to

Table 8.1: UK defense equipment imports

	1980	*1985*	*1990*	*1995*	*2000*	*2001*
Total imports (£ mill, current prices)	147	246	627	1,433	1,660	1,804
Imports (£ mill, constant 2001 prices)	367	476	857	1,722	1,729	1,804
Imports as share of UK equipment spending (%)	3	3	7.1	16.8	17.1	18
By type (£ m, current prices)						
a) Military aircraft	2	18	316	1,137	1,363	1,609
b) Missiles	65	119	190	134	142	138
By origin (£m, current prices) NATO	141	220	471	1,162	1,383	1,718

Notes: (i) Military aircraft includes parts; missiles comprises guided weapons, missiles and parts. NATO includes other Europe. (ii) Constant prices based on UK GDP deflator at market prices.
Source: DASA (2002).

Boeing, representing over 50 percent of Boeing's offset commitment, and, typically, Rolls Royce aero-engines would have been purchased without the offset agreement: hence, they were not new work resulting from the offset obligation. It has been estimated that for developed nations such as the UK, genuinely new business might be some 25 to 50 percent of the total offset (Martin and Hartley, 1995). Similarly, for imports purchased directly "off-the-shelf," there are few opportunities for acquiring new technology since the development work on the project will have been completed. And offsets raise questions about the definition of high technology. For the UK purchase of Boeing AWACS, work on the aircraft galleys and toilets counted as high technology.

Both contractors and governments have every incentive to exaggerate the benefits of offsets and ignore the costs. But all policy changes involve gainers and losers, and offsets are no exception (there are no free lunches). They are seen as a means of redistributing jobs from exporting to importing nations, but there are efficiency losses to the importer if it is a higher-cost nation and if there are more efficient alternative uses for its resources. Offsets are attractive to vote-sensitive politicians who can use them to justify the import of defense equipment by claiming that they are protecting the national defense industry, its jobs, and technology. The reality is that a nation's defense industry based on offset business will lose the capability for design and systems integration associated with independent national programs and European collaborative projects. This then raises the question of how a nation might combine its search for low-cost defense equipment while maintaining a high-technology defense industrial base: is JSF the solution?

The UK and JSF: the project history

The Joint Strike Fighter (JSF) program is a requirement for an affordable new tactical aircraft combining the needs of the US Air Force, the US Navy, and the US Marine Corps. The Air Force requirement is for a low-cost replacement for its F-16 and A-10 aircraft with a flyaway unit-cost target of $28 million (1994 prices); the US Navy requires a carrier-capable aircraft with stealth features and long range to replace its F-18s and the A-6 with a flyaway unit-cost target of $31–38 million (1994 prices); and the US Marine Corps requires a short take-off and vertical landing variant (STO VL) to replace its AV-8B aircraft with a flyaway unit-cost target of $30–35 million (1994 prices). In addition, the UK Royal Navy and the RAF require a replacement for their Harrier STOVL aircraft. Cost savings on the JSF come from commonality among the three variants, with some 70 to 80 percent of the value of the aircraft being common, and from the long production run for the US forces. Estimates suggest that jointness will lead to cost savings of some 18 to 25 percent for development, production, and operation (life-cycle costs) as compared to the costs of three independently developed aircraft types (CBO, 1997, p. 42). The original requirement for the US forces was 2,852 aircraft plus a further 150 aircraft for the UK, resulting in a total planned order for 3,002 aircraft. UK involvement in the program was at both industry and government level.

Competition was used to determine which two firms would be selected for the JSF Concept Demonstration Phase. Three bids were submitted comprising five firms. In November 1996, the US Department of Defense selected the proposals from Boeing and Lockheed Martin with the losing bid from a team composed of McDonnell Douglas, Northrop Grumman, and British Aerospace (B AE). Boeing (X-32) and Lockheed Martin (X-35) were each awarded contracts to build two JSF concept demonstrator aircraft with flight tests planned for 2000 and on the basis of which the preferred bidder was to be selected. This competing prototype stage was a “fly-before-you-buy” competition, with each rival designing and flying demonstration aircraft, evolving their preferred weapon systems concepts for the production designs, and submitting proposals for the next phase, called Engineering and Manufacturing Development (EMD). In December 1996, Boeing announced a merger with McDonnell Douglas, and in May-June 1997 Lockheed Martin announced that Northrop Grumman and BAE had joined its JSF team.

Following a Memorandum of Understanding (MoU) signed with the US government in December 1995, the UK government entered the Concept Demonstration Phase (CDP) of the JSF program in November 1996. JSF is an international program in which the UK entered as a full partner, with a 10 percent share of the CDP of the project. As a result, the UK contributed $200 million as a full collaborative partner during the $2 billion CDP. Other nations involved in the JSF program by 2000 were Canada, Denmark, Italy, Norway, and the Netherlands, each being associate or informed partner nations, with each contributing under 2 percent of the CDP costs (these five nations contributed a total of $50 million to CDP costs).

UK participation in the JSF program was initially subject to an investment appraisal undertaken in 1995. At this stage, the UK requirement was for 60 aircraft only (later raised to 150 aircraft). On this initial basis, it was estimated that an UK-only program would be between 60 and 105 percent more expensive than UK participation in JSF, and JSF also compared favorably on cost criteria with variants of existing aircraft such as Eurofighter and F-18. However, it was also estimated that it would be some 4 percent cheaper to buy JSF directly from the USA rather than participate as a partner in the joint program (NAO, 2001, p. 59). In return for the extra cost of being a full partner, the UK obtains possible military, economic, industrial, and technology benefits, although there is no formal arrangement for distributing work between UK and US industry. At this stage of the procurement process, prior to EMD, questions arose about the possible economic benefits to the UK of its participation in the JSF program.

Economic benefits to the UK

The results in this section are based on a study of the economic and industrial benefits to the UK of its requirement for a Future Carrier Borne Aircraft (FCBA; Hartley, 2000). The focus is on the impacts on the UK aerospace industry and the economy in terms of employment, technology, and exports. The study was undertaken in early 2000 during the CDP and before the award of the EMD to the preferred contractor. At that time, the US JSF was a strong contender for the FCBA; other contenders included a naval version of Eurofighter Typhoon, a development of the Harrier (Harrier III), the US F-18 E/F, and the French Dassault Rafale.

On JSF, two industrial teams were competing for the EMD contract. The Boeing team included UK suppliers in its international supplier team. These included Flight Refuelling, Messier Dowty, and Martin Baker. The Lockheed Martin team was a partnership with Northrop Grumman and BAE Systems (its JSF project team, formerly BAE Military Aircraft). BAE Systems had an exclusive partnership agreement with Lockheed Martin on the JSF. This provides BAE Systems (JSF team) with at least 10 percent of the work on all phases of the JSF and for all customers, including export customers (BAE has responsibility for the rear fuselage and tail section). For example, with initial planned orders for some 3,000 units and forecast export sales of 2,000 aircraft, BAEs work share could be the equivalent of 500 aircraft (airframes only). The exclusive partnership meant that BAE was in a risky “win-lose” position during the CDP of the program. In contrast, some UK firms were involved in both rival industrial teams, and hence, were in a safe “win-win” position during the CDP. Rolls Royce, for example, was involved in the Pratt and Whitney engines for both teams’ STOVL variants and was also involved in the rival General Electric engine. Similarly, the former GEC Marconi company was involved in both teams; but with the creation of BAE Systems following the merger between BAE and GEC Marconi, BAE Systems Avionics became suppliers to both teams. A postal survey of suppliers involved in the Lockheed Martin JSF showed that a majority were also involved in the Boeing JSF program (Hartley, 2000). That some of the major UK aerospace equipment suppliers were involved in both teams should be no surprise. Both Boeing and Lockheed Martin will have selected those UK firms which have a competitive advantage and could enhance their bids, and these are likely to be the same group of UK companies.

Table 8.2: Overall evaluation: a UK perspective, 2000

Aircraft	*Number of jobs (per annum)*	*Quality of jobs*	*Technology*	*Exports per UK*	*Overall rank*
LM JSF	EMD: 3,000+ production: 12,500	high	potentially good on technology transfer	2,000	1
Boeing JSF	production: 5,500–9,500	medium/ high	some for firms in Boeing supplier team	2,000	2
Harrier III	R&D: 4,100+ production: 9,000+	high	good (?)	some(?)	2
Naval Euro-fighter	production: 10, 345–13, 150	high	some	limited	4
Boeing F-18E/F	offset: 6,000	low	little	none	5
French Rafale	offset: 4,000	low	little	none	6

Note: LM=Lockheed Martin; EMD=Engineering and Manufacturing Development. The results are based on a study completed in June 2000 (Hartley, 2000).

Assessment of the likely economic and industrial benefits to the UK of the rival JSF teams during the Concept Demonstration Phase was influenced by the exclusive partnership agreement between Lockheed Martin and BAE Systems. Selection of the Lockheed Martin JSF offered direct economic benefits to BAE Systems and to its suppliers in the form of jobs, technology, and exports. BAE Systems and the UK might benefit from technology transfer, including stealth technology on the airframe, and battlefield management and data access. However, transfer of sensitive technologies to the UK will depend on the US-UK MoU, on associated technology access agreements, and on the approval of the US Congress. There could also be technology transfer from the UK to the USA in the form of STOVL and lean manufacturing technologies. Further benefits to BAE Systems and the UK would include the retention of the company as part of the UK defense industrial base and possible involvement in life-cycle support for UK and European JSF aircraft (e.g., servicing, repairs, and maintenance).

The results of the study of the economic and industrial impacts for the UK from the rival JSF teams and the alternative aircraft are shown in table 8.2. The rankings are based on quantitative and qualitative assessments made in 2000 before contractor selection and before the start of full development. Clearly, military performance, cost, and delivery will dominate the final choice, but if the competing aircraft are identical or similar on military performance and cost, then wider economic and industrial criteria enter the procurement choice. Table 8.2 presents the type of evidence which the UK government needed to identify the trade-offs for each aircraft option and to make an informed procurement choice.

Estimates of employment shown in table 8.2 were based on interviews with Lockheed Martin, BAE Systems (for JSF, Eurofighter, and Harrier III), and Rolls Royce, as well as on a postal survey of UK equipment suppliers mostly involved on the Lockheed Martin JSF. Estimates for the Boeing JSF were based on data in the public domain and on plausible assumptions (e.g., about work awarded by Boeing to BAE Systems): hence, the range of estimates for Boeing shown in table 8.2, Overall, for firms in the UK aerospace industry, UK participation in the EMD and production phases of the JSF program is expected to require highly-skilled and high-wage jobs; and with wages reflecting productivity, these are high-productivity jobs compared with manufacturing and all UK industries. Typically, jobs on JSF will pay annual salaries which in 2000 were over 30 percent higher than the average for other industries and for some skills salaries were 2.4 times higher (i.e., compared with manufacturing and all industries in Great Britain; ONS, 2000).

Evaluations were also made of the economic and industrial impacts of alternative UK aircraft, namely, a naval Eurofighter and Harrier III. Compared with JSF, the broad choices for the UK were between a small share of a large-scale JSF program and a large share of a small-scale naval Eurofighter or involvement in Harrier III (on which there was little information in the public domain). The overseas aircraft were assumed to involve a 100 percent offset, but assuming that such offsets created only 25 to 50 percent new jobs in the UK (not all of which would be in the UK aerospace industry). For all the alternative aircraft, assumptions were made about their likely unit-costs which provided the basis for estimating employment.

Overall, on economic and industrial criteria, the Lockheed Martin JSF was ranked top and offered the UK the best value for money (table 8.2) A key and distinctive element in the Lockheed Martin JSF is its exclusive partnership with BAE Systems which offered the UK company an involvement in EMD, a share in the total sales of JSF to all customers, and possible access to high technology. The Lockheed Martin JSF also contributes to maintaining B AE Systems as an important component of the UK aerospace industry and of the national defense industrial base.

Joint second-ranked options were the Boeing JSF and Harrier III, each with different benefits for the UK. This ranking was based on a qualitative assessment as there were insufficient data to discriminate more clearly between the two options. In particular, the assumptions for Harrier III should be regarded as tentative and “heroic,” reflecting the uncertainties surrounding this project. Naval Eurofighter was ranked next, offering some technology, plus substantial production work, but limited export prospects compared with JSF. Nonetheless, naval Eurofighter provided the UK government with some bargaining power and a credible-threat strategy when negotiating an EMD agreement with the USA. The offset options are ranked lowest, reflecting the number of jobs, their low quality, little technology, and the absence of export prospects (Hartley, 2000).

The UK and JSF: the position in 2003

In January 2001, the US and UK governments agreed an MoU for the UK to participate fully in the System Development and Demonstration Phase of the JSF program (SDD: previously known as EMD) which was estimated to cost $25 billion. The UK is the only Level 1 partner in the program and will contribute some £1.3 billion to the SDD phase (about 8 percent of SDD costs), plus about £600 million to fund work on UK-specific requirements. An immediate benefit was that the UK obtained key project roles in the JSF Joint Program Office and "…played a major part in the contractor selection process" (NAO, 2002, p. 99). For example, the UKs close involvement led to inclusion of some UK weapons in the operational requirement. It is not known whether the UKs input into contractor selection included an assessment of the wider economic benefits offered by the rival JSF projects and their industrial teams.

In October 2001, the US awarded a "winner takes all" contract to Lockheed Martin for the estimated 126 month SDD phase of the JSF program (F-35). Subsequently, the UK announced its selection of the STOVL variant for its Future Carrier Borne Aircraft requirement, with an estimated in-service date of 2012. Lockheed Martin's marketing literature on its F-35 claims that it will create or sustain 5,000 UK jobs in about 70 companies during the SDD phase and 8,400 UK direct jobs per year for the 30 year production and support phase. Overall, the UK will receive an estimated share of 15 to 20 percent of the JSF program. The UK is also one of eight international partners on the program: the others are Australia, Canada, Denmark, Italy, the Netherlands, Norway, and Turkey. The eight partners have collectively committed $4.5 billion to JSF development costs (e.g., Australia will contribute almost $150 million and Norway $125 million to the SDD phase).

Th JSF program is not without its problems and critics. Already, the US has reduced its requirement for the Navy and Marine Corps, there are concerns about the reliability of the cost estimates, especially for the low-cost variant, there remain significant project risks during the development stage, and there are uncertainties about the commitment of each of the US forces to acquiring a common aircraft. Further concerns have been expressed by some of the international partners about their failure to obtain work share on the JSF (e.g., Australia, Norway). As a result, the JSF Program Office has modified its global best value approach to placing subcontracts with partner nations to include a "strategic best value" exemption. This permits certain work to be set aside for contractors that meet cost and schedule requirements (e.g., components such as arrester hooks and some ground equipment).

The Netherlands and JSF

In early 2001, the Netherlands undertook studies into the military, cost, and industrial implications of its F-16 replacement program (RUSI, 2001). The rival European and US aircraft for this replacement were the Eurofighter Typhoon, the Gripen, Rafale, an advanced F-16, the JSF, and the F-18 E/F. A study was undertaken into the wider economic and industrial impacts (industrial participation) for the Netherlands of these alternatives. Information was provided by some of the major rivals, namely, Eurofighter Typhoon, the Saab/BAE Systems Gripen, the advanced F-16, and the rival JSF teams. These studies need to be treated with caution: they reflect the marketing efforts of the rival bidders and as such are subject to contractor bias. The focus is on the economic impact in terms of employment, regional effects, and technology transfer. Moreover, the study was undertaken at an early stage in the Netherlands' F-16 replacement program when there were major uncertainties and estimates were no more than tentative, broad orders of magnitude. Despite such limitations, the study provided valuable information on the wider economic and industrial impacts of the procurement choices, with a focus on the Netherlands' aerospace and defense industries. This was a rare opportunity to obtain information on the range and variety of industrial participation offers from rival bidders (Hartley, 2001, chapter 6). There follows an outline and evaluation of the industrial impacts of each rival aircraft.

Eurofighter Typhoon

Typhoon offered the Netherlands the opportunity to become a partner in the development, manufacture, and support of future versions and enhancements of Typhoon. On this basis, it would qualify for pre-contract participation in the development work for Typhoon Tranche 3 aircraft, as well as for participation in other European defense technology programs (e.g., radar, missiles). Post-contract participation included opportunities for Dutch industry to be involved in the production of Typhoon airframes and engine parts and components, in avionics and accessories equipment, and in logistics support. There were further post-contract opportunities for Netherlands industry to be involved in non-Typhoon defense projects involving Eurofighter partner nations (e.g., Airbus, warships). Eurofighter had already identified a number of Dutch companies and institutes which offered potential for cooperation (e.g,. Stork-Fokker, Fokker Space, Sun Electric Systems, Signaal).

Eurofighter partner nations claimed that a Netherlands decision to buy Typhoon would result in two sets of economic benefits. First, it was claimed that the pre-contract investment would produce an estimated economic return between three and five times the value of the original Netherlands pre-contract funding (e.g., a pre-contract investment by the Netherlands of, say, €0.2 billion would lead to €0.6 to 1.0 billion of post-contract work). Second, there would be additional offsets according to standard Dutch requirements. Possible work areas included continued development of Typhoon and production of items for Tranche 3 aircraft as well as involvement in logistic support for all these aircraft, together with participation in other current and future programs (EF, 2000).

Typhoon offered opportunities for Dutch industry to be involved in development work, as well as the more conventional offset participation in production work. However, from the published literature (EF, 2000), it was not possible to reach any informed judgment on the valuation of the possible technology benefits to Dutch industry. There was also uncertainty about the availability of future funding for Typhoon Tranche 3 aircraft. But compared with the US aircraft, Typhoon offered the Netherlands a different set of economic benefits associated with the "European dimension." These included participation in Europe's largest defense program, including cooperation with Europe's largest defense and aerospace companies and access to some 350 major suppliers to the Typhoon program. On this basis, Dutch policymakers were required to reach some judgment on the potential military, economic, and industrial benefits of participating in Europe's largest defense program.

Saab/BAE Systems Gripen

The Gripen was claimed to offer "a unique industrial co-operation opportunity involving companies and organisations related to Saab-BAE Systems" (Saab/BAE, 2000). This unique industrial cooperation package aimed to establish an equal partnership in an industrial development program for Gripen together with further work opportunities in aerospace and defense as well as in non-aerospace and non-defense activities. Saab/BAE Systems were willing to consider a minimum commitment of a 100 percent offset for the Gripen program with a significant share in the aerospace and defense sectors, the aim being a "long-term partnership on a sound commercial basis" (Saab/BAE, 2000). Unlike traditional offsets, the Gripen industrial cooperation package stressed the creation of a "long-term partnership resulting in the establishment of profitable businesses which will continue developing long after the fulfilment of the offset commitment" (Saab/BAE, 2000). Saab/BAE Systems were offering the Dutch government and its air force a partnership in future developments of the Gripen, with the Netherlands qualifying as a full partner in the future Gripen-2010 programs (and with the Swedish government committed to funding the future development of Gripen).

Some of the features of the Gripen industrial cooperation package offered to the Netherlands included (Saab/BAE, 2000):

> the creation of a Gripen Design and Development Center in Holland with direct employment of 40–50 personnel and a 2–3 year lead time to create such a Center. Technology transfer was to be facilitated by the co-location of Dutch personnel to Sweden at an early stage in the program;
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> Dutch industrial participation in what was then the world's largest defense company (Saab/BAE Systems), together with links to the partners on Gripen (Volvo and Ericsson) and to their major suppliers (e.g., General Electric, Lockheed Martin, Lucas Aerospace);
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> access to non-aerospace and non-defense industrial cooperation through Saab's membership of Investor AB, one of the world's largest industrial holding companies;
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> participation in other Saab/BAE technology development programs (e.g., UAVs, Meteor missile, Airbus, A400M airlifter);
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> involvement in a range of Gripen enhancement work, with opportunities for Dutch industry to participate in both development and production work. A number of Dutch companies had already been identified as potential partners (e.g., Fokker Aerospace, Fokker Elmo, Fokker Space, Signaal, NLR, Edim, Senior Aerospace).

The Gripen industrial package had four distinctive features. First, it offered the Netherlands an equal partnership with Sweden in the development of the next version of

Gripen. In contrast, the Netherlands was to be a junior partner in the Typhoon, Rafale, and JSF aircraft. Second, it focused on developing long-term partnerships which were to be "profitable and sustainable" long after the achievement of the offset commitment. Third, it offered a range of cooperation from aerospace and defense to non-aerospace and non-defense activities. Fourth, the risks associated with the Gripen aircraft were relatively low compared with some of its rivals. Gripen was in service and the Swedish government was committed to funding Gripen-2010. In contrast, at that stage, JSF had not started full development and funding for Typhoon Tranche 3 did not exist.

Rafale

The French Rafale was reported to offer Dutch industry participation in both development and production work on a European aircraft. An indication of the possible Rafale industrial participation for the Netherlands can be obtained from its bid for the then new fighter aircraft contract from Greece. The Rafale industrial cooperation program based on a partnership among Dassault, SNECMA, and Thomson-CSF offered Greece a global partnership with an invitation to join the Rafale agency with "extensive industrial and technological benefits" (Richard, 2000). Greece was offered access to state-of-the-art technologies developed for Rafale together with participation in future developments for the Rafale mission system as part of a joint development team. It was also offered a final assembly line for the Greek Rafales and manufacturing, assembly, and testing as a sole source of major items for all production Rafales (e.g., aircraft assemblies, mission systems equipments). Engine issues were to be addressed in a similar fashion and there would be Greek involvement in logistic support. It was estimated that a purchase of 60 Rafales by Greece would lead to 1,000 jobs in Greece, 20 years of employment, €1,800 million for the Greek defense industry, and an overall total of €4,800 million from the global partnership (Miltech, 2000, pp. 99–100). Of course, with this and other industrial participation deals, the opportunity cost question cannot be ignored. A direct buy "off-the-shelf' from the manufacturer is likely to be a lower-cost solution, so that any savings could then be injected as spending into the Dutch economy with such alternative spending offering jobs, technology, and export benefits.

Advanced F-16

Under the original 1975 agreement, the Netherlands and three other European nations (Belgium, Denmark, Norway) purchased 348 F-16 aircraft with the Europeans receiving a work share of 58 percent of the value of their initial order. Final assembly lines were established at Fokker in the Netherlands and SABCA in Belgium. This was a coproduction program without design involvement, with any extra costs associated with the program being absorbed by the four European participating governments. The Dutch companies involved in the F-16 coproduction program included DAF (landing gear components), Fokker (final assembly), Oldelft (head-up display), Philips (engine components), Signaal (radar antenna), and Simmonds (fuel measuring control unit).

Lockheed Martin claimed that the advanced F-16 would involve a continuation and expansion of the "highly successful industrial programs that Lockheed Martin has enjoyed with Dutch industry…over the last three decades. Lockheed Martin would rely on these previous successes to develop a new industrial participation program in support of the advanced F-16" (LM, 2000a). The company also offered offset work on its other programs (e.g., F-16, Hercules).

Previous experience with the original 1975 European purchase of F-l 6s provides some indication of the likely economic impact of offsets associated with an advanced F-16 purchase. In principle, offsets offer both military and economic advantages. Nations buy an established and proven aircraft so avoiding risks, they save on the R&D costs which would be involved in an independent solution, they help to retain the national defense industrial base, and they provide employment, technology transfers, and balance of payments benefits. However, these claimed benefits are rarely supported with empirical evidence, nor is careful consideration given to the likely costs of offsets (there are no free lunches). For example, reference to the technology benefits of offsets rely on *ad hoc* examples, such as the transfer of US production and management technology to European co-producers. Rarely is consideration given to assessing the market value of such technology and who pays for these benefits (governments or firms).

While the overall offset targets for the F-16 coproduction program were achieved, the distribution of offset between the four European nations was unequal due to their different aerospace capabilities and their competitiveness. The Netherlands received offsets of 52.8 and 76.1 percent against their respective targets of 58 percent (minimum) and 80 percent (target level: Struys, 1996). Lockheed Martin claimed that for the Netherlands, the F-16 coproduction agreement had "… resulted in value added participation approaching £3 billion" (LM, 2000a). But "value added participation" and "approaching" were not defined, nor was reference made to whether the figures were in current or constant prices. If the figure means sales, then over a 25 year period, it represents an average of under $120 million *per annum* (most likely in current prices). Nor was the program costless. Estimates suggest that compared with buying directly from General Dynamics, the Europeans paid an extra 34 percent for their F-16s (Rich *et al.*, 1981). Such estimates do not include the costs of the extra time and delays involved in the F-16 coproduction program compared with a direct buy from the USA (e.g., the costs of running-on old equipment).

JSF options

At the time of the study, JSF was a competition between the Boeing and Lockheed Martin teams (see project history above). This section assesses the information available on the Netherlands industrial participation in the rival JSF teams. In 2000, the Boeing JSF One Team comprised a group of companies "fundamentally involved in the overall design, execution and management of the entire program" with each company chosen on the basis of its commitment to quality and affordability (Flight, 2000, p. 23). In addition to Boeing, the One Team comprised 34 leading aerospace companies from the US A, UK, Denmark, and the Netherlands. The Dutch companies listed as One Team members were Fokker (airframe structural details, wire bundles), Perot Systems (supportability systems), and Philips (airframe structural details). Other Dutch companies were likely to be involved if Boeing were selected for the development phase and if the Netherlands selected the JSF as its F-16 replacement. Also, the Boeing JSF offered opportunities for applying its commercial airplane expertise (e.g., on the development of the Boeing 777 and new generation 737 airliners) and its international competitiveness in the jet airliner market to achieving the cost and performance targets on JSF. On this basis, any Boeing offset for the Netherlands might involve the transfer of production technology from its civil aircraft business.

Lockheed Martin provided some company information on the likely involvement of Dutch companies in its JSF project. Much depended on whether the Netherlands joined the full development program as a Level 2 partner for JSF (an order for 100 aircraft was assumed). The original F-16 coproduction agreement involved no design or support responsibility and was a "build-to-print" arrangement. With JSF, Lockheed Martin industrial partners are "fully integrated into the design, production and support team" and typically retain design and support responsibility over the life of a program. Industrial partners are chosen on the basis of "best value" in terms of affordability and technical competence. By early 2001, Lockheed Martin had selected a number of Dutch companies for the next phase of the program and these were chosen regardless of the Netherlands' participation in the development phase. These companies were Fokker Aerostructures (Stork: structural components, moveable doors), Fokker Elmo (Stork: wiring harness), Signaal USFA (cyrogenic coolers), and DPCC (a consortium: PHM systems). Lockheed Martin regarded the Netherlands as "the largest potential international industrial participant with the exception of the UK," and it estimated the value to Dutch industry of its involvement in the JSF project at $3 to 4 billion, with some estimates based on involvement in full development totaling $6 to 7 billion over the life of the program (1994 prices: LM, 2000b). Technological involvement for Dutch companies ranged from software to electronics to structural components, together with technology spin-off benefits. It was also estimated that Dutch involvement in the full development phase would lead the US government to waive its R&D levy of some $5 to 7 million per aircraft.

Predictably, many Dutch companies were involved in both rival JSF teams (i.e., a win-win situation): one estimate was that 80 percent of Dutch firms were involved in both teams and firms which have international reputations for competitiveness and technical excellence will be attractive to both Boeing and Lockheed Martin (Hartley, 2001, p. 121). Both JSF teams offered Dutch companies opportunities for design and development work on their components. Comparing the offset arrangements for the two JSF projects, using the available but limited information, it was expected that Lockheed Martin would have a competitive advantage in industrial partnerships and offsets for the Netherlands. Based on its long experience with the European F-16 coproduction agreement, it has a detailed knowledge of the Dutch aerospace and defense industries and the national government (i.e., its entry costs were borne by that program).

F-18E/F

Little information was available on the industrial participation for this option. Nonetheless, some broad generalizations were possible. If the Netherlands were to select the F-18 E/F, it would likely be offered a conventional offset package based on production work for the aircraft. Since the F-18 E/F aircraft has been developed, there seems little opportunity for Dutch industry to be involved in development work on the aircraft, although Boeing could have offered participation in other military and civil projects.

Overall evaluation

Each of the industrial participation and offset proposals have different features, requiring policymakers to specify their obj ectives clearly, identify their priorities, and place valuations on their various aims. The rival industrial participation packages differed in the following respects:

the risks and uncertainties associated with the rival aircraft and their associated offset packages; in 2001, some aircraft already existed and had entered operational service while others had not started full development; the extent of any partnership in the development program; the options ranged from no partnership to various forms of junior partnership to equal partnership in development work;

a program with Europe or the USA and their associated aerospace companies; the type of industrial partnership and its duration. For example, are there opportunities for industrial participation outside the project in non-defense and non-aerospace work; and is the offset or partnership for the duration of the procurement only or is a more permanent and longer-term commitment being offered?

the involvement of Dutch companies. The rival bids are likely to involve a common core of Dutch companies. The different bids will then need to be evaluated in terms of the amount and type of work offered to the common core of Dutch companies, the importance of these companies to the Dutch defense and aerospace industries, and the involvement of other Dutch companies outside the common core;

the need for quantification. The rival bids need to be expressed in terms of the estimated number of jobs, their skills, location, and their duration. Since offsets are prone to exaggeration, the reliability of a firm's offset estimates might be determined by its willingness to include the industrial participation content into a legally enforceable contract.

Any overall evaluation of the rival bids from a Netherlands perspective has to be tentative. There was a lack of data for an informed ranking, so the evaluation was

Table 8.3: Overall evaluation: a Netherlands perspective, 2001

Aircraft	*Development work*	*Production work*	*Technology*	*Other offsets*	*Ranking*
Saab/BAE Gripen	equal partner offset	yes: 100% long-term partnership	yes	industrial package	1
Typhoon	junior partner	yes: Europe's largest defense project	some	involvement in other current/ future projects	2

Rafale	junior partner	yes: final assembly	some	possible (?)	3
LM JSF	some	yes	some	value=$3–4/ $6–7 billion	4
LM Adv. F-16	limited (?)	yes: experience from F-16 coprod	little (?)	offsets on other LM programs	5
Boeing JSF	some	yes	some	–	5
F-18E/F	none	yes	none	possible work on other Boeing projects	7

based on a qualitative assessment of the economic and industrial benefits of the rival bids. Military performance and cost criteria were not part of this evaluation. The results are presented in table 8.3 where there is confidence about the extremes of the ranking (numbers one, two, and seven), but less about the middle order. Nor is any attempt made to quantify the differences in the rankings (e.g., there might be only marginal differences between rankings 4 and 5). In the event, the Netherlands decided to be an international partner in the JSF development program.

Conclusion: JSF as a model for future international collaboration?

European collaborations in defense equipment have been characterized by major inefficiencies resulting from inter-governmental bureaucracy, industrial management problems, and work share requirements. In contrast, European collaboration in large jet airliners has been successful, with Airbus as the only rival to Boeing (a duopoly).

Economic theory offers some policy guidelines for international collaboration in defense projects. First, international collaboration has to offer cost savings compared with an equivalent national project and ideally compared with the least-cost alternative (importing). In other words, analyzing such collaborations as clubs requires that club membership be worthwhile (i.e., benefits *at least* equal to the costs of membership). Second, an *efficient* international club would allocate work on the basis of comparative advantage determined by competition. For example, a country with a comparative advantage in high technology would undertake the development work on the project and there would be no requirement to award work to the losing bidders. Nor would countries have an automatic right to a share of the development work based on the size of their order *(juste retour)*. Third, the project needs to be managed by a single prime contractor subject to an incentive-contract offering rewards for good performance and penalties for poor performance.

JSF seems closer to the policy guidelines of economic theory than the traditional European collaborations. There were competitions at the design and prototype stages on JSF. For the prototype competition, there were two prime contractors each selecting partner companies and major suppliers on the basis of their technical excellence and international competitiveness (i.e., selection on commercial rather than political criteria). The ultimate winner of the development contract was awarded the contract on a “winner takes all” basis (i.e., no requirement to offer some work to Boeing as the loser).

Interestingly, a number of suppliers were associated with both JSF industrial teams (a win-win situation), whereas BAE Systems adopted a high-risk strategy and agreed an exclusive partnership with Lockheed Martin (a win-lose position).

The international partners on the JSF program are unique in providing a North American, European, and Australian partnership, with each contributing to the project's development costs. In return, each will expect some benefits from their contributions. Benefits might take the form of exemption from paying an R&D levy on any purchases, an opportunity to bid for work on the program, priority in deliveries, and access to technical and performance data on the aircraft. These benefits have to be greater than the alternative of a direct buy "off-the-shelf." The UK is different in that it is the only Level 1 partner, paying a premium of 4 percent compared with a direct import. Clearly, the international partners will expect and will lobby for some work share, but any work awarded will be determined by the prime contractor and not by governments and the work allocations will not be allowed to increase the final price of the aircraft. Nor is there an elaborate inter-governmental bureaucracy with responsibility for project management. Similarly, there are no complex industrial management problems and the associated need to create a new international company (cf. Eurofighter): Lockheed Martin and its industrial partners (Northrop Grumman and BAE Systems) have prime contractor responsibility and their suppliers are subject to normal commercial supply contracts.

JSF provides a model for future international collaboration. It is a collaboration based on economic rather than political criteria. Of course, critics might claim that it is not a genuine international collaboration of the type pursued in Europe but instead is an American-led and dominated program with the US retaining a monopoly of design and development and retention of stealth technology. The UK as a Level 1 player is different; but for the other international partners it will be argued that JSF is a new package of the old US idea whereby international collaboration is seen as sharing some production work.

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