Chapter 8

Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States

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Chapter 8

Government Support of the Large Commercial Aircraft Industries of Japan, Europe, and the United States[1]

The commercial aircraft industry[2] is often characterized by superlatives. It has the largest trade surplus of any U.S. industry. There are fewer large firms dominating the world market than in perhaps any other industry. It is marked by larger economies of scale than most other industries. In every country that has a domestic commercial aircraft assembler, the hand of government is prominent in the industry's behavior and performance. Because of the industry's distinctive characteristics, it pays to be cautious in drawing broader lessons about the efficacy of government involvement in the industry's competitiveness.

Even with an appropriate dose of caution, however, some conclusions about the nature. of government/business relationships in the commercial aircraft industry sound familiar. The United States has influenced the commercial aircraft industry primarily through spinoffs from other programs, rather than directly or with the intent of improving competitiveness. Four European nations (France, Germany, Great Britain, and Spain) have played a much more decisive role in boosting the competitiveness of their aircraft consortium, Airbus Industrie. The amount and kind of support extended to Airbus from these governments has been far more effective in improving its competitiveness than the military spinoffs and basic research programs of NASA in the United States. While Japanese industrial policy has failed to produce a domestic assembler of large commercial aircraft, Japan, like Europe, has expended a great deal of money and effort aimed directly at improving competitiveness in the aircraft industry. Japanese firms have become world-class subsystems makers. In short, both Japan and Europe have directly aimed public policies and supports at competitiveness, and have gotten results. In comparison, American companies have gotten much less consistent or effective boosts from policies that were directed toward other goals.

Several advanced countries and even some developing nations have decided that the capacity to build commercial aircraft is important to their national self-interest. The preamble to the General Agreement on Tariffs and Trade (GATT) Agreement on Trade in Civil Aircraft acknowledges this, stating that countries have made that pact recognizing that the aircraft sector is viewed as a particularly important component of economic and industrial policy.[3] The principal reasons are the industry's links to national security, the generation of technologies that may spill over to other industries, the contributions of aircraft exports to a positive balance of payments, the creation of well paying jobs, and national pride.

Government supports for the commercial aircraft industry have taken various forms:[4] synergies between military and commercial work, funding of civil R&D, direct financial supports for specific commercial projects, encouragement of the growth of domestic demand and efforts to steer it toward domestic suppliers, export assistance, and efforts to organize industry so it is well suited to international competition. The most important effects in the United States have come from the National Aeronautics and Space Administration (NASA) and Department of Defense (DoD) programs. While promoting competitiveness has been a goal of NASA's aeronautics program, other benefits include the side effects of actions taken for reasons unrelated to competitiveness. As a result, the benefits have consistently been smaller than if promotion of international competitiveness had been a major policy objective. In particular, the indirect benefits U.S. companies received from DoD programs were substantial in the past, but have declined as military and civil technologies have diverged and the air transport industry has matured. In contrast, the direct financial supports used heavily in Europe and Japan have been provided specifically for the purpose of improving competitiveness. While they have been costly, they have also been effective and appear likely to continue.

Table 8-1 assesses the relative importance of each of the major types of support to the success of commercial aircraft manufacturers in Europe, Japan, and the United States.

Table 8-l—Benefits to Commercial Aircraft and Component Manufacturers of Various Types of Government Actions[a]

	Us.	Japan	Europe
Direct financial aid	small (↓)	large (=)	very large (=)
Military R&D plus procurements	medium (↓)	small (↑)	medium (↓)
Civil R&D	medium (=)	small (=)	small (=)
Control of domestic demand	none (=)	small (=)	medium (↓)
Export assistance	small (=)	none (=)	small (=)
Organizing the industry	none (=)	small (=)	medium (=)

Legend: (↑) = increasing in importance
(=) = remaining at about the same level of importance
(↓) = decreasing in importance

[a]This table compares total benefits, not efficiency. That fact that two categories get the same rating does not mean that the costs of providing those supports are necessarily equal. Also, some types of government actions affect some parts of the industry more than others-e. g., military/civil synergies are greater for engine makers than airframes. This table represents a rough average for the whole industry.

SOURCE: Office of Technology Assessment, 1991.

RISK AND THE ROLE OF GOVERNMENTS

The principal way these supports benefit manufacturers is by reducing risk. Risk in the commercial aircraft business is higher than in most others. Both technological and market uncertainties are great, and the costs of launching a new model are enormous. This combination of uncertainties and high costs adds up to big risks. Bringing out a new airplane can mean betting the company-and more than one company has lost the bet. Government support can reduce these risks to a point where the relation between risks and expected rewards is favorable and a company can proceed to launch a new model or adopt a new technology.[5]

The use of state-of-the-art systems in each new generation of aircraft confronts manufacturers with significant technological risks. A project may be years and billions of dollars into its development before a technical obstacle is discovered that delays or stops the effort. Rolls Royce's effort to make all-composite fan blades for the Lockheed L-1011 engine failed, causing delay in the plane's introduction and ultimately the bankruptcy of both companies. Boeing's 747 got heavier and heavier throughout the development process, requiring more and more powerful engines and driving up costs. Pan Am, the 747's launch customer, Pratt & Whitney, the engine makers, and Boeing were all nearly bankrupted by the effort. Even when technological uncertainty does not threaten the launch of a model, it affects the manufacturer's decision about whether to adopt advanced subsystems and components. The opportunity to develop and prove advanced technology at the expense of the government, in either military or civil R&D projects, can help give companies enough confidence in the cost and performance of the new systems to just@ incorporating them into products.

More than technological failure, failure in the market has been the source of disasters in the aircraft business. As a rule, an aircraft manufacturer needs to sell at least 500 units of a model for it to break even. Of the 26 basic airplane types introduced worldwide since the beginning of the jet age, only 6 have sold as many as 500 (another 4 are likely to do so before their production runs end). Seven sold less than 120 copies. Only four or five have been profitable.[6] A report by First Boston Corp. concludes that in 1984, the jet transport aircraft programs then launched had accumulated total losses of $40 billion on total sales of $180 billion (in 1984 dollars). "The essential message [of these figures] is that economic failure is the norm in the civil aircraft business. '

Considering this record, no one in this business commits to building anew design before assembling a number of launch customers.[8] These early orders not only assure the manufacturer that it will sell at least that many units, they are needed to convince the manufacturer's financial backers that the model has sufficient appeal to airlines to justify committing funds. Government influence over airlines' choice of which aircraft to buy when a launch is pending can directly affect the manufacturer's decision, as can large government orders of military aircraft that are similar or identical to commercial models. Governments naturally favor domestic suppliers for their military needs, but in the commercial business, airlines' purchase decisions frequently turn on narrow differences in performance and price among competing airplanes. A nudge from the airline's government--e.g., to choose a domestic company or one that buys some parts or subsystems from domestic companies--can be decisive.

In addition to technological and market uncertainties, financial risks are also high. Aircraft development costs have risen dramatically since the early days of air transport, as table 8-2 shows.

The $1.2 billion development costs of the 747, spent between December 1965 and January 1969, were over 3 times the $372 million capitalization of the Boeing company. The $1.1 billion cost of developing the DC-10 was over 3 times greater than the $364 million capitalization of the Douglas company.[9] The combined launch costs of Boeing's 757 and 767 in the late 1970s again exceeded the net worth of the company.[10] Coupled with these tall investment requirements are long lead times before the project reaches positive cash flow, and an even longer wait before the break-even point. Typically, it takes 4 to 5 years to develop, test, and certify a new aircraft, 2 years longer for the engines, and as much as 10 years from then to recover the initial investment—if that point is ever reached.[11] Figure 8-1 shows the cash flow of a typical aircraft program.

Unless they have government support, manufacturers finance these costs from four sources:

1. retained earnings,
2. issues of debt and equity,
3. progress payments from customers, and
4. cost-sharing with subcontractors and partners.

These sources may not be sufficient to enable a manufacturer to launch a new model, and in some instances, only if governments are willing to directly assume much of the financial risk can the project proceed. Governments can offer loan guarantees or credits with payback contingent on success; or they may pay outright some costs of developing new projects, either by providing funds at preferential rates or by contracting for development work.

Although government assistance to the large commercial aircraft industry is undeniably important overall, the effects of individual government supports vary greatly. Government support for R&D may not advance a company's technological development. On the one hand, it may stimulate a company to increase its own funding for R&D, or it may supplement the fro's own R&D program. Alternatively, it may supplant R&D the company would have done anyway. Financial assistance with the launch of new designs may enable firms to proceed with models that otherwise would never have made it past paper studies, but it may also remove market disciplines and encourage a firm to proceed without frost establishing that sufficient demand exists, leading to costly market failures. Government-provided financing to ease companies' cash flows during production may enable firms to increase production rates and improve market share, but it may diminish pressures for the firm to institute needed cost-controlling measures. The effectiveness of government support depends not only on the degree to which it is offered but also on the type given and the way in which it is delivered.

The following sections describe government policies related to the aircraft industries of the United States, Japan, and Europe, focusing on the motives, content, and results of government interactions with the industry.

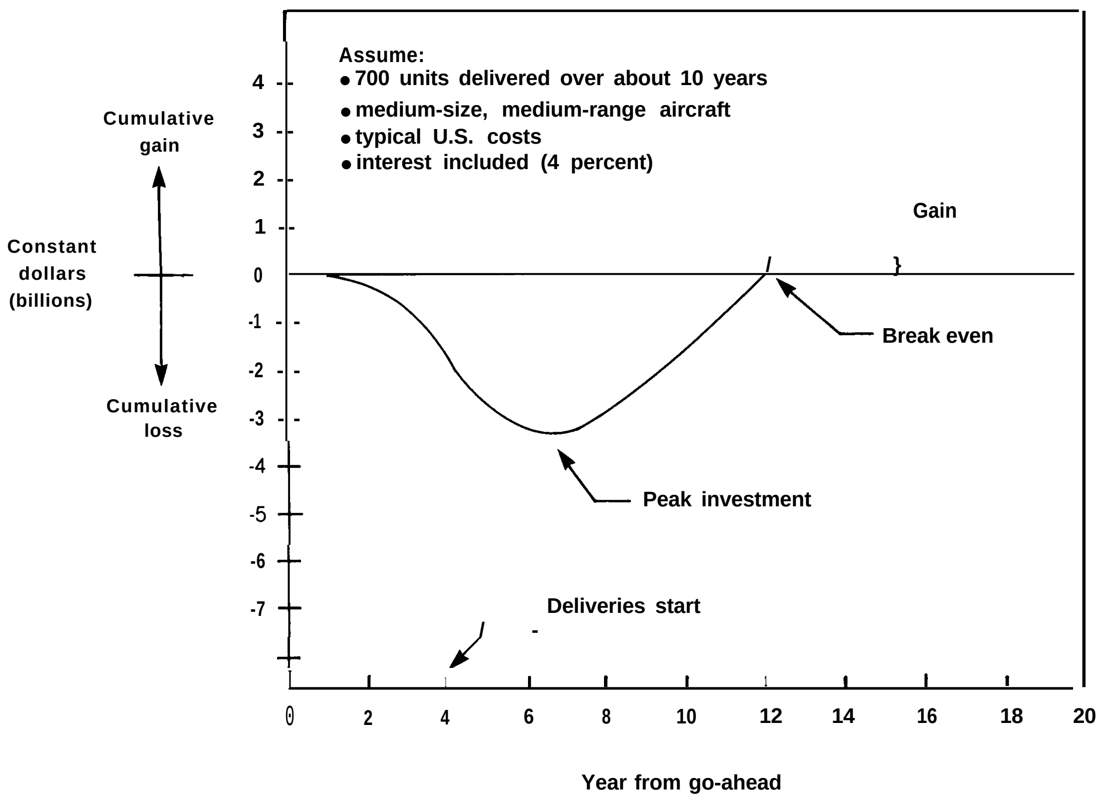
Table 8-2—Aircraft Development Costs

Aircraft	Entered service	Development cost in dollars (millions)	Development cost in 1991 dollars (millions)	Development cost per seat in 1991 dollars (millions)
DC-3	1936	$0.3	3	0.1
DC-6	1947	14	90	1.7
DC-8	1959	112	600	3.75
747	1970	1,200	3,300	7.3
777	1995'	5,000'	4,300"	14.0'

● Estimate.

SOURCE: U.S. Department of Defense, National Aeronautics and Space Administration, and Department of Transportation, *R&D* Contributions *to* Aviation Progress (RADCAP) (Springfield, VA: National Technical Information Service, August, 1972), vol. II, app. 9, p. 21.1991 values are computed using aerospace industry price deflators for 19S5-19S9 and GNP deflators and estimates for other years.

Figure 8-l—Cumulative Cash Flow for an Aircraft Project



SOURCE: Boeing Commercial Airplane Co.

UNITED STATES

Motives

The U.S. Government today avoids helping any particular industry compete in world markets. However, the government does have policies related to national defense and trade, and takes actions that affect transportation and technology. The U.S. commercial aircraft industry has benefited from measures taken in these areas.

The greatest benefits for U.S. commercial aircraft manufacturers have been side effects of the government's commitment to building and maintaining a strong defense industrial and technology base. The use of advanced technology in national defense has generated both financial and technological benefits for companies that produce commercial as well as military aircraft. Several factors make the commercial aircraft industry of special interest to defense policymakers. Technological advances made for commercial aircraft show up in military hardware and concurrent production of commercial aircraft reduces military aircraft costs. The supplier base and work force skills needed for rapid military buildups are maintained by civil aircraft production, and the design teams needed for military projects are kept together by commercial work during periods of weak military demand.[12] These benefits are likely to become even more important in the future as defense spending is scaled back and military hardware comes to rely more heavily on dual-use technologies.[13]

Support for civil aeronautical R&D is strong in the United States, compared with that for most other areas of the civilian economy .14 The traditional rationale for government support of NASA technology programs is that the resulting R&D compensates for the tendency of private firms to do less than the socially optimal levels of R&D because they are unable to capture fully the returns of their investments. This is the standard economic justification for civil technology policies in general.[15] Although NASA's official mission does not go father towards helping U.S. aircraft manufacturers compete, this alone does provide some competitiveness benefits to US. firms.

The belief that air travel is important for U.S. transportation needs has led to measures such as airline regulation, subsidies for air mail, Federal and local subsidies for airports, safety monitoring, and the management of the air traffic environment. Though most of these measures were aimed primarily at air transportation, they fostered the early growth of a strong domestic market for commercial aircraft, which in turn benefited U.S. producers.[16]

As for trade policy, U.S. commitment to free trade served the country's aircraft manufacturers well for many years after World War II. During the war, the United States had become the world's greatest producer of aircraft and it emerged at war's end with the industry intact; this helped establish the industry's dominance. With the strong domestic market and continuing military-civil connections giving U.S. producers significant advantages, a liberal trade environment favored the American industry. The government also used its influence to discourage foreign support for competitors (though with limited success), maintained a tariff of 5 percent or more on aircraft imports until 1980, and provided export assistance to U.S. producers to compensate for perceived unfair practices. In the 1980s, while U.S. trade deficits reached record levels, commercial aircraft exports rose. Indeed, aircraft is the United States' largest exporting industry. The U.S. trade surplus in transport aircraft (not counting spare parts) from 1985 to 1989 (the latest year for which firm figures are available) was $35 billion. Although sales of commercial transport aircraft represented less than 0.3 percent of U.S. gross national product (GNP) in 1989, they accounted for nearly 3.4percent of the dollar value of U.S. merchandise exports.[17]

Among this list of U.S. Government actions and policies, only NASA's support for civil aeronautical R&D constitutes a deliberate effort to help the competitiveness of commercial aircraft builders. Benefits the industry has received in other areas, especially from the synergies between military and civil aircraft work, have been the results of government actions taken with goals other than competitiveness in mind.

Military-Commercial Synergies

The U.S. Government policy that has most affected the competitiveness of the commercial aircraft industry is procurement of military aircraft and funding of the related R&D. Most important among the effects of military work are technological synergies. In a few cases, whole systems developed for the military have been spun off to commercial applications, reducing development costs and risks to the commercial users. In others, large military orders for products or technologies designed for commercial uses (or those closely related) have boosted production runs, and therefore lowered costs by allowing companies to achieve economies of scale, learn the production process, and share overhead costs. Military development programs have assumed the risks of proving advanced technologies, giving commercial users the confidence to adopt them. Often, the benefits accrue not so much to aircraft assemblers, but at the subsystem level, in materials, or in manufacturing process technology. Though synergies appear to be declining, the boost the industry was given in the past when military and civil technology were more similar accounts for a portion of the success of the industry today.

Examples of these synergies are numerous. Boeing's civil 707 and the military KC-135 tanker were both developed from a common prototype and shared 20 percent of the tooling, reducing costs to both commercial and government customers. The prototype itself drew heavily on advances made in the B-47 and B-52 bomber programs, including the flexible swept wing and the podded engine. The core of General Electric's largest commercial engine was originally developed for the C-5 military transport, and the core of the company's medium-sized commercial engine came from the B-1 bomber. At the GE Aircraft Engines plant in Evendale, Ohio, commercial and military engines move through many of the same production stations. Both sides of the business share a common management structure, common ordering and inventory, common manufacturing processes, and common R&D facilities. Only finance and marketing are separated. McDonnell Douglas sold 60 of its commercial DC-1OS to the Air Force for use as air refueling tankers, thus increasing the total profits of the program and helping to keep production going until the company was ready to commit to the derivative MD-11. The development of lightweight composite materials is being led by the military; commercial users have been unwilling to adopt the materials until they have acquired sufficient service experience that their safety is assured. Military users are providing that experi-

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ence. Though much of the development cost of the ring laser gyroscope for inertial reference systems was borne by companies, military funding at key moments in the development process, together with the promise of a combined military and civil market, spurred the private investment. Pratt & Whitney's F-1 17 engine for the Air Force C-17 cargo plane was adapted from the commercial P&W 2037 engine and bought "off the shelf' by the military, thereby increasing production runs, spreading development and overhead costs, and decreasing costs to both military and commercial users.

Military projects help train aeronautical engineers. The original 747 design team consisted of engineers who had been trained and familiarized with the tasks involved in designing wide-bodies during the C-5A military transport competition.[18] One McDonnell Douglas official suggested that even if the C-17 program were canceled, it would still have had the beneficial effect of training 2,000 engineers the company could then employ on commercial work.

Until the last decade, military work was profitable. This, combined with the often alternating cycles of the commercial and military sides of the business, generated some financial benefits for companies involved in both commercial and military work.[19] For example, according to a leading aircraft industry analyst, Boeing's commercial activities lost money during the first 20 years of jet production; the company was carried during that period by steady profits in its military business, especially the B-52 and Minuteman missile.[20] In 1967, despite an order backlog of $2.3 billion in commercial aircraft, the commercial Douglas Co. was forced to merge with the primarily military McDonnell Aircraft Corp.[21] The cash infusion from McDonnell not only saved Douglas from bankruptcy but enabled the company to bring out the DC-10 (introduced in 1971).

However, the defense connection has not been an unqua.idled boon. Defense and commercial technologies have been gradually diverging since the beginning of the jet age, so opportunities for the commercial side to benefit from military developments are shrinkfh g. Commercial requirements are driving high reliability, low fuel consumption, and low noise technologies, while defense needs are pushing low radar detection, high speeds, and high maneuverability. Some synergies remain, but they are smaller than they once were.

Other aspects of the defense business are negative as well. Military projects can divert limited resources (e.g., highly specialized aeronautical engineers) away from commercial projects. Export controls limit international markets, military requirements may entrench processes and mentalities ill-suited to commercial competition, and efforts to standardize military hardware with allies may have transferred commercially relevant technology to competitors. Classification of defense systems often makes advances in military technology unavailable to commercial divisions even within the same company, and much of the DoD aircraft development and procurement budget is spent with firms that have no significant commercial activity. In the late 1980s and early 1990s, defense aircraft work in the United States has become less profitable than it once was, creating a burden on profitable commercial operations.

DoD's procurement regulations often create de facto requirements for firms to separate their military and commercial development and production, reducing the potential benefits of simultaneous involvement in both sides of the business.[22] The costs generated by DoD's close oversight or detailed specification of hardware and production processes cause some companies to separate military and commercial production that they might have combined if DoD provided for more latitude.[23] Even when companies still find it beneficial to combine military and commercial production, the benefits are less than if DoD procurement regulations and contract specifications allowed more flexibility.[24] Burdensome military requirements are unlikely to leave commercial producers less competitive than if the companies had no military business at all, but they do interfere with the ability of firms to take maximum advantage of available synergies.

The defense business has generated benefits for and imposed extra costs on firms also involved in commercial work. These benefits have been far less than they could have been if promoting commercial competitiveness were a major policy goal.

Government Funding for Civil Aeronautical R&D

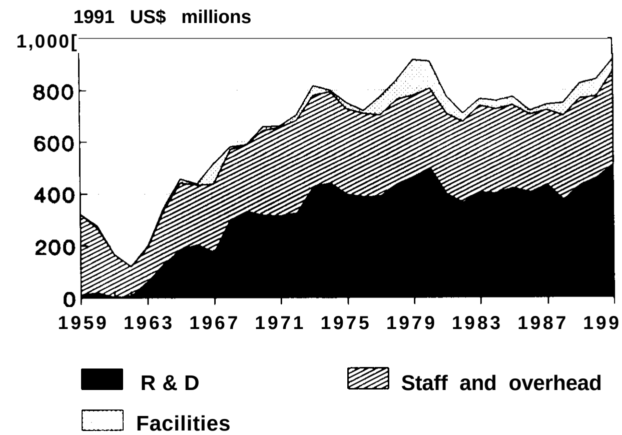
In addition to the often indirect and generally unintended benefits to commercial manufacturers of military aircraft, the U.S. Government has directly funded R&D for civil applications through the aeronautics program at NASA and its predecessor, the National Advisory Committee on Aeronautics (NACA). Figure 8-2 shows the funding history for NASA's aeronautics program. Their research projects have produced many advances that improved the performance and safety of aircraft. However, the gains for the competitiveness of U.S. aircraft manufacturers have been less clear.

One undisputed benefit has been the research and test facilities NASA provides. Since companies are relieved of the need to maintain redundant facilities of their own, the NASA facilities reduce costs for individual firms and improve the efficiency of the industry as a whole. Most used by companies are the wind tunnels. According to NASA officials, every commercial aircraft built in the United States has been tested in NASA wind tunnels. Computers, simulators, aircraft for flight testing, and other specialized equipment are also used by industry, sometimes quite heavily. Aircraft companies account for 15 to 20 percent of the use of the Numerical Aerodynamic Simulation computers, the world's most advanced facility for computational fluid dynamics (CFD). In 1984, the replacement value of all of NASA's aeronautics facilities was estimated at $10 billion.[25]

NASA's aeronautics R&D program also benefits U.S. aircraft producers, though it does not always bestow a competitive advantage. The program helps U.S. aircraft manufactures develop and adopt new technologies by conducting research inhouse and then transferring the results to companies and by contracting with companies to perform specific research tasks, usually in cooperation with inhouse NASA research. Further, NASA researchers act as a free consulting service for industry engineers having technical problems. The availability of technologies developed and tested at NASA's expense and risk helps aircraft manufacturers incorporate new capabilities into their products at diminished cost or risk, just as military developments do.

Sometimes, these technological advances result in gains in competitiveness for the firms that use them. Examples include NASA's work in CFD, which helped Boeing find positions to locate the nacelles on the wings of the 737, 757, and 767 to minimize drag. NASA's energy efficiency projects of the late 1970s and 1980s helped U.S. engine makers decrease fuel consumption of their engines, increasing their appeal to airlines looking for ways

Figure 8-2—NASA Aeronautics Funding, 1959-91



SOURCE: NASA.

to cut operating costs. NASA's noise reduction projects helped U.S. engine makers build quieter engines, which resulted in significant competitive advantages when Congress passed noise limitations in 1968 and tightened them in 1974.

However, NASA's technology advances can provide U.S. firms with a competitive advantage only if they are able to apply the technology before their foreign competitors. The record has been mixed. Cases in which foreign competitors have applied NASA research first are numerous. Winglets made their first commercial appearance on Airbus planes. The supercritical wing was frost employed on the Airbus A320.[26] In Japan, the Shin-Meiwa Co., which builds some composite parts for Boeing, claims to have learned much of its carbon fiber technology from NASA publications. NASA advances in engine technology will be applied by Société Nationale d'Étude et de Construction de Moteurs d'Aviation (SNECMA), the French aircraft engine company, in its high-pressure compressor for the GE-90.[27] Advances made in short take-off and landing (STOL) technology have been used more by the Canadian company DeHavilland (to the degree that they have been used at all) in its Dash-7 aircraft than by U.S. firms.[28] Safety-related research, such as that on the prevention of icing, transfers quickly-as indeed it should.

NASA publishes nearly all of its research in open literature. Even when U.S. companies do get access to NASA technology first, they may transfer this technology overseas in technology licensing arrangements and through joint ventures. Foreign governments' support of their own aircraft industries in ways that reduce the risks of adopting new technologies is a major reason for foreign firms taking advantage of NASA-generated advances sooner than U.S. firms do.

U.S. firms do have some advantages in getting to NASA R&D first. Most importantly, they often participate in the research projects, gaining valuable "hands-on" experience. NASA also tries to limit the distribution of the most valuable results, though with limited success.

It is likely that the competitiveness benefits to U.S. firms equal only a portion of the cost of NASA's aeronautical R&D program. While the facilities and some portion of NASA's aeronautics R&D budget may be viewed as a support to the industry, to view the whole budget as such is an overestimate of those effects.[29]

Direct Financial Assistance

Though synergies between military and civil work and NASA's aeronautics R&D program are the main sources of U.S. Government benefits to commercial producers, other government actions have also helped. On three occasions, the U.S. Government has provided direct financial supports to the industry. In the late 1960s, poor sales and costs overruns of the L-1011 drove Lockheed to the brink of bankruptcy. In 1971, the Nixon administration approved a loan guarantee of $250 million, which saved the company but failed to prevent it from exiting the commercial business within a decade. In any case, the government's main purpose was to save a defense contractor, not a commercial aircraft producer.[30] Commercial interests were more directly involved in the case of the Douglas Aircraft Co. When the company approached bankruptcy in 1967, the government eased its merger with the McDonnell Aircraft Co. by providing a loan guarantee of $75 million, helping to save its commercial aircraft business.[31] Here, the government's interest was more in the realm of the domestic economy-jobs and community economic base-than in international competitiveness. In neither situation was the guarantee called upon. In the third case, the U.S. Government spent roughly $1 billion between 1961 and 1971 on the development of a supersonic transport (SST) to rival the Concorde. The program was canceled long before an aircraft flew but did generate some technology that appeared in later subsonic aircraft.

The Lockheed and Douglas loan guarantees and the SST program are the most significant direct financial assistance the U.S. commercial aircraft industry has received from the U.S. Government, yet they pale in comparison to the funding available in other countries. Further, these interventions were infrequent and ad hoc, not part of a coherent strategy to support the commercial aircraft manufacturing industry.

Promotion of a Domestic Market

The government has helped U.S. aircraft manufacturers indirectly through its efforts to promote the growth of domestic air travel. The size and strength of the American market is a major reason for the success of U.S. commercial aircraft manufacturers. The earliest commercial use of air transport was in carrying the mail. Deliberate government subsidies enabled carriers to use larger, faster planes better suited to carrying passengers as well.[32] In 1938, the Civil Aviation Administration (CAA) was set up within the Department of Commerce to provide "direct subsidies to promote passenger travel, economic regulation of the airlines, air traffic control, and safety. ' In 1948, the CAA was divided into the Civil Aeronautics Board (CAB), with responsibility to regulate routes and fares, and the Federal Aviation Administration (FAA) to oversee safety and the air-traffic environment.[33] Safety standards, efficient management of the airspace, and technical support for the construction of airports provided by the FAA all helped to make air travel a safe and desirable means of transport. Regulation, which ended in 1978, enabled airlines to pass on the costs of more expensive, more advanced aircraft to the traveling public,[34] so airlines were quick to replace old aircraft and to introduce technological innovations.[35] Though these benefits have largely disappeared in the last decade, historically they were very important to the industry.

Export Assistance

Finally, the U.S. Government has helped aircraft manufacturers export by providing credit on favorable terms through the Export Import Bank (Eximbank). Over the decade from 1967 to 1977, the Eximbank provided $5.77 billion in loans covering the export sales of 1,185 commercial jets worth $12.8 billion.[36] In the early 1970s, when the aircraft market was so weak that U.S. aircraft manufacturers faced serious threats to their survival, the Eximbank became so heavily involved in financing aircraft exports that it acquired the nickname "Boeing's bank." However, two developments have greatly undermined the importance of export financing. First, an agreement among the major aircraft exporters called the Large Aircraft Sector Understanding (LASU), concluded under the auspices of the Organization for Economic Cooperation and Development (OECD), established a minimum rate governments could offer. Second, in the mid- 1980s, the financial markets realized that aircraft retain their value well and can be held as collateral against the loans used to buy them. Bank rates for aircraft purchase loans consequently dropped very close to rates available with government guarantees, greatly diminishing the role of export financing.[37] Boeing officials state the Eximbank now finances only five to seven sales of Boeing planes annually, or about 2 percent of the company's sales.

JAPAN

Motives

In contrast to the United States, the explicit goal of the Japanese Government in its support for commercial aircraft manufacturers was and still is promoting the industry's development. Japanese Government support for this industry is properly seen as another step up the technological ladder in a long succession of targeted industries.

After the U.S. occupation of Japan ended, most of the companies that had built military aircraft during WWII returned to the business. Their first significant work came from the overhaul of U.S. military aircraft used in the Korean War, followed by licensed production of U.S. military designs. In the 1960s, a project to build a twin-engine turbo-prop gave companies their first experience designing commercial transports and their first taste of the business. Following the costly failure of this domestic venture, airframe work shifted to subcontracting for Boeing and engine work focused on the multinational V2500. Military work dominates the industry today, though the proportion of commercial work is increasing rapidly. The total civil production remains less than 5 percent of that of the United States.

The legal foundation for Japanese Government support of the industry was laid with the passage of the Aircraft Industry Manufacturing Law in July, 1952, barely 2 months after the end of the occupation made aviation activities possible. The First Aircraft Industry Promotion Law of 1954 led to heavy subsidization of the industry in the 1960s. Aircraft were first designated a "targeted industry" by Japan's Ministry of International Trade and Industry (MITI) in its "vision" for the 1970s, and then again in the document for the 1980s.[38] (The 1990s vision did not name any specific industries.)

As in the United States, military work has helped Japanese companies' efforts to become major commercial suppliers, though relatively small government orders, use of licensed designs (rather than domestically developed ones), and restrictions on exports of military goods have limited the spillover benefits. Although Japanese planners may use military aircraft production to help develop their commercial aircraft industry, the overall benefits from the military connection is less than in the United States.

Promoting economic growth has been and remains the prime motivation for Japanese Government support of industry, and the nation's GNP is now the fastest growing among advanced nations. Partly as a result, Japanese firms now face an acute labor shortage. The need for growth to increase employment is not great. Instead, Japanese planners see the commercial aircraft industry as an opportunity to learn advanced new technologies that may spill over into other sectors, moving firms into more knowledge intensive and higher added-value work.[39] Planners see aircraft production as an area in which recently industrialized countries are unlikely to threaten more technologically advanced nations as they have in industries like steel and ship building.

Japanese companies produced Y159 billion worth ($1.2 billion at 135 yen to the dollar) of commercial aircraft-related goods and services in 1989.[40] Though government supports have greatly helped Japanese companies achieve such successes as they have, these supports have not been sufficient to fully overcome the obstacles the industry faced in the post-WWII period.

Direct Financial Supports

Early Japanese Government efforts to promote the development of a domestic commercial aircraft industry involved heavy government funding in the hope of rapidly catching up with the West. However, after the failure of its first effort and the high costs it entailed, the government switched to a more gradual approach. In the projects of the 1960s, most of the risk was borne by the government. Now much more of the risk is borne by companies, though the government funds involved are still substantial. The Japanese Government appears to have accepted that catch-up will be a decades-long process.

Government support remains very in important to the Japanese industry. Japan's post-war hiatus in aircraft manufacture, its history of licensed production of military aircraft, and limited defense budgets have left Japanese aircraft companies in a weak position from which to compete in international markets. Because commercial aircraft manufacturers in Europe, the United States, and other countries have received many benefits from their governments, the prices of aircraft made in those countries do not reflect their full cost. Without government support, Japanese aircraft manufacturers would have to be far more efficient producers and have better products to offer than their foreign competitors in order to make a profit. They have not yet achieved that.[41] Each of the major Japanese aircraft companies has suffered several costly failures in commercial aircraft ventures, and they are reluctant to repeat the experience. Japan's major aircraft manufacturers are all large, highly diversified companies, and senior management is reluctant to divert too much of their technical talent to the aircraft business.

The Japanese Government has offered aircraft firms direct financial supports in various forms. Though funds involved have been far less than those provided in Europe, they have been large in relation to the size of the industry in Japan. Initially, Japan's Ministry of International Trade and Industry (MITI) used equity participation and guarantees against losses incurred during the production phase of a project. For the YS-11 airplane, a 64-passenger, twin-engine turbo-prop of the 1960s, MITI provided 54 percent of the initial capitalization and guaranteed the participating firms against production phase losses.[42] By the time production was canceled in 1973, only 182 YS-lls had been sold, two-thirds of those to domestic customers, and the project had accrued debts of Y28 billion ($207 million), four times its initial capitalization of Y7.8 billion.[43] Most of these debts were never repaid and were quietly forgiven by the government when the management organization was dissolved in 1986.[44]

Later, MITI used *hojokin--loans* offered directly from the Ministry, to be repaid only if the project is successful. The *hojokin* were offered only for expenses incurred during the product development phase, not during production.[45] In 1977, Japan's three largest aircraft manufacturers formed a consortium to make 15 percent of Boeing's 767 (first delivered in 1982).* The Japanese partners' total costs came to Y29 billion during the official development phase, 1978 through 1983, MITI-directed funding covered Y14.7 billion. In addition, companies spent on their own an estimated VY20 billion on production facilities and tooling, for a total investment of about Y49 billion before revenues started flowing. The Japanese companies lost money on the venture for several years because of the fall of the dollar and because production was low. However, the terms of the development loans were favorable to the companies; MITI slowed the loans' early repayment because the program was so costly to the Japanese producers.

In 1986, MITI introduced a new system whereby loans for up to 50 percent of the product development costs of aircraft projects are made available by the government-owned Japan Development Bank (JDB). MITI pays the interest on these JDB loans with further loans from a new government-funded organization called the International Aircraft Development Fund (IADF). Companies begin repaying the IADF loans only when the project reaches the break-even point, so the JDB and IADF loans combined provide firms with nearly interest-free financing. Though companies are officially required to fully repay the loans' principal, if projects funded through this system ran into severe difficulty it is likely MITI would ease repayment requirements.[47] The result is a system of launch aid similar to that used in Europe. Japanese companies' 20-percent participation in Boeing's 777, launched in late 1990, will probably cost $1.2 to $1.3 billion. Of this, $700 million is development expense, half of which is eligible for MITI support (the remaining costs are for facilities, tooling, and operating expenses, which MITI does not cover) .48 JDB has committed to supplying Y17.4 billion ($129 million) for the 777 for 1991, and MITI has requested Y798 million ($6 million) in IADF funds that "will be applied as a subsidy for 50 percent of the especially high-risk development costs and for the interest on the JDB loan.' '[49]

While the Japanese Government is gradually reducing its share of the costs and risks of commercial aircraft projects, direct financial supports continue to benefit Japanese fins. MITI supports enable companies to make much larger investments in commercial aircraft projects than they would otherwise, thereby speeding the development of the industry.

Military-Commercial Synergies

Japanese aircraft companies have achieved synergies between their military and commercial businesses in many of the same ways U.S. firms have. The total benefits, however, are much lower than in the United States because Japanese procurement budgets are far smaller and the R&D budgets smaller still. Japan's defense budget has hovered around 1 percent of the country's GNP for four decades.[50] In 1988, Japan spent Y3.7 trillion ($27.4 billion) on its military. Military aircraft procurements have ranged between 7 and 12 percent of the total defense budget (Y381 billion in 1988) for the last two decades.[51] In comparison, the U.S. defense budget for 1988 was $290.4 billion, $28.2 billion of which was for aircraft procurement.[52] The contrast is even greater for R&D. In fiscal year 1991, U.S. Department of Defense R&D was $37.8 billion and about 15 percent of the $285.6 billion defense budget,[53] while Japan's military R&D spending was only Y114 billion ($844 million) and 3 percent of the defense budget (the highest percentage it has ever been) .54

Synergies between military and civil work are reduced by Japan's propensity to license U.S. designs, rather than developing them domestically. This has denied Japanese firms the opportunity to develop valuable design and development skills. In fiscal year 1991, Japan paid the United States $816 million in royalties for these licenses, roughly the equivalent of the entire Japanese military R&D budget.[55]

On the positive side is the flexibility the Japanese Defense Agency allows its contractors, enabling Japanese aircraft manufacturers to realize some synergies much more easily than U.S. producers. For example, the JDA allows contractors to retain any intellectual property rights generated in development projects, enabling firms to use research results in commercial products at their discretion. Further, the JDA deliberately seeks out technologies with dual-use potential, increasing chances for synergies.[56]

Other Mechanisms

Japan has a civil aeronautical R&D program similar to NASA's, which generates some competitive benefits for Japanese firms. The mission and activities of the National Aerospace Laboratories (NAL) are much like NASA's; however funding is less than one-tenth as much. In translating its technical advances into competitive benefits for Japanese fins, NAL suffers from some of the same difficulties NASA faces. The technology development programs run by MITI's Agency of Industrial Science and Technology have been more important than NAL's efforts. The FJR-710 engine program, which was almost entirely funded by MITI through its Agency of Industrial Science and Technology (AIST) for a total of Y19.8 billion ($147 million) between 1971 and 1981, formed the basis for Japan's current 23-percent share of the V2500 engine program.[57] Officials at Ishikawajima Harima Heavy Industries state that without strong government support, they would never have attempted such a technologically risky venture. Currently, AIST is funding a research project in hypersonic propulsion systems, aimed at putting Japanese manufacturers in a position to participate in building a high-speed commercial transport that may be built early in the next century.

The Japanese Government has aided its aircraft manufacturers in two other significant ways. First, by creating a preference among domestic airlines for aircraft that have large portions built in Japan, the Japanese Government encourages foreign manufacturers to increase the amount of work they subcontract in Japan. A combination of close relationships between government officials and senior airline executives and roughly $1 billion in preferential interest rate loans that MITI can offer for aircraft imports gives the government great influence.[58] This is not to say that the government makes overt demands of foreign manufacturers. Rather, foreign companies are aware of these interactions and take into account that substantial subcontracting in Japan may help them sell to Japanese airlines.

Second, the Japanese Government has helped Japanese firms to pool their resources in consortia, decreasing the risk any one firm faces and increasing their bargaining power with potential partners. The main purpose of the First Aircraft Industry Promotion Law of 1954 was to create cartels within the industry.[59] That law and its successors not only offer inducements for cooperation among fins; they require Japanese companies to obtain formal MITI approval before entering the aircraft business.[60] Consortia in the aircraft industry are remarkable because unlike those in other Japanese industries, which handle R&D only up to the precompetitive stage, these extend into the production stage.[61] All of Japan's major international projects-the 767, the V2500, and the 777—have been handled through such consortia.

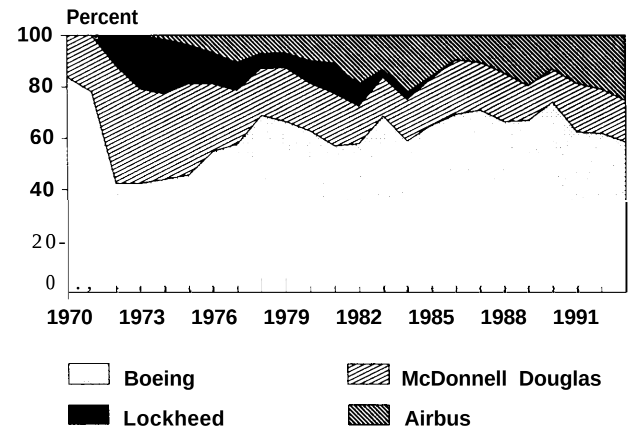
EUROPE[62]

Motives

In contrast to the predominantly indirect benefits U.S. commercial aircraft manufacturers have received from the U.S. Government, European firms have benefited from government policies aimed directly at promoting their competitiveness. Several motives lie behind this direct support. European planners value aircraft manufacture explicitly for the employment it creates. An Airbus official explained that the main reason the collaboration works is that by creating jobs in an export industry, Airbus enables the member countries to capture jobs from other parts of the world. (Figure 8-3 shows the historical and expected growth in Airbus' share of the world market. For a brief description of the history and current structure of Airbus, see box 8-A.) The member governments are less concerned about global economic efficiency and rules of comparative advantage than with meeting immediate domestic needs. With government commitment to full employment, policymakers view the thousands of jobs Airbus creates in England, France, Germany, and other European countries as well worth the costs of the supports provided.[63]

Another reason European governments support the industry is concern that without support for their domestic manufacturers, European airlines will be forced to rely solely on two U.S. suppliers. By supporting a challenger, European governments force U.S. manufacturers to keep their prices low. As a result, some portion of every dollar European governments spend supporting Airbus is returned to their economies in lower airplane costs. Baldwin and Krugman examined the competition between the Airbus A300 and the rival Boeing 767 and con-

Figure 8-3-World Market Share, 1970-92
Large Commercial Transport Airplane
by Value of Deliveries



SOURCE: Boeing, *World Jet Airplane* Inventory, "19S9 and Bear Stearns," Aerospace *Industry Review*, May 9, 1991.

eluded that European consumers do benefit, but by less than what they estimate European taxpayers paid for those benefits. "Overall it seems that the A300 project constituted a beggar-thy-neighbor and beggar-thyself policy for Europe."[64]

National prestige plays a big role. Though the influence of pride is difficult to trace, aircraft projects have broad popular support, making them an easy cause for politicians to endorse.[65] Europeans are proud of a long history of achievement in aeronautics, including the first supersonic transport, the first jet transport, the first jet engine, and even claims of the frost powered flight. Airbus Industrie (AI) executives describe an "Airbus reflex" in the French Government. Airbus does not even have to go to government offices to solicit help; the venture is so highly regarded that the relevant ministries come to Airbus on their own and ask, "How can we help?"

Just as in the United States, national defense policies aimed at maintainingg autonomous and technologically advanced military production capabilities have greatly increased the ability of firms to design, develop, and build large commercial transports. In addition, regulation and state ownership of airlines, put in place to meet air transport policy goals, provide European aircraft manufacturers with reliable domestic customers. Support for aircraft manufacture is justified on trade grounds as substituting domestic goods for imports and boosting exports. Planners perceive the products as driving

Box 8-A—Airbus

Airbus discussions began in 1966. In 1%7, the French, British, and German Governments agreed on a joint venture in which Britain and France would each hold shares of 37.5 percent, and Germany would hold 25 percent. France agreed to allow Britain's Rolls Royce the lead in the engine development with a 75 percent share of the new RB207, with France and Germany each getting 12.5 percent. The French, in return, would be for final assembly and design leadership. In 1%9, the British withdrew from the project due to a combination of rising costs, lack of airline interest, BAC's reluctance to concede design leadership to the French, and Roll Royce's desire to build the RB-211 engine for the L-101 1. France and Germany then took over co-leadership of the venture, securing financial assistance from Spain and the Netherlands. Britain's Hawker-Siddeley remained as a subcontractor responsible for the design and production of the wing. In 1979, Britain rejoined Airbus and the consortium decided to pursue a strategy of offering a "family" of aircraft, committing to the long-range A300-600 and the small A310. The A300 was introduced in 1974, the A310 in 1983, the A300-600 in 1985, and the A320 in 1988. The long-range A340 and large A330 are scheduled for first flights in 1992 and 1993 respectively, followed by the derivative A321.

Airbus Industrie (AI) is now a consortium of Aerospatiale (37.9 percent), Deutsche Airbus (37.9 percent), British Aerospace (20 percent), and CASA of Spain (4.2 percent), constituted under French law as a Groupment d'Interet Economique (GIE)-a structure originally designed to let small French vineyards operate on a cooperative basis. Airbus acts only as the organizational focus of the partnership. As a GIE, it is unable to retain any earnings, and it is neither required to report financial results nor liable to pay taxes on its profits.[1] Every 15 days, AI distributes any funds on hand to its members or calls on them for more funds if needed. The members are fully and separately liable for all Al activities, effectively giving AI a credit standing equivalent to the sum of the credit worthiness of all its members. AI's only functions are product planning, sales and marketing, some customer support, and management of the partnership.

AI owns no production facilities. All of the design, development, and production work is done by the members under contract to AI. The division of workshare among the partners roughly corresponds to the size of the partners' membership share, with the allocation of each portion decided in negotiation. This system puts the members in the strange position of being both the owners and the subcontractors. AI negotiates the contracts for each partner's share separately. The other partners do not know the terms of these contracts, and AI itself knows nothing about what the individual members' costs are, only what the "transfer prices" are. This system has been the cause of frustration in the United States and Europe; it is impossible to tell whether the whole of Airbus is operating profitably, for not even AI knows. Losses or profits incurred by AI are virtually meaningless. Members maybe making profits as subcontractors while losing money as owners, or the reverse maybe true. (Members do not disclose Airbus-related profits or losses in their individual financial reports.)

Government influence has been pervasive throughout Airbus' history. AI itself receives no financial support from governments. All of the disbursement and repayment of launch aid and other supports is handled among the members and their governments. Officially, the members do not know the terms of the support the others receive. Nevertheless, the member governments do coordinate with each other regarding the support they will give each project, and approval from an oversight committee of government officials, the Executive Agency, is required for the launch of a new model. Government-to-government negotiations were even more important than those between the companies themselves during the founding days of Airbus. Government policymakers even intruded into the design process (though this has diminished since). Government decisions were at the heart of the withdrawal and later reentry of the British, as well as the ability of the French and Germans to carry on without them.

[1] *British Aerospace Public Limited Company Offer of Ordinary Share, May* 1, 1985, p. 20, as cited in Gellman Research Associates, op. cit., p. 1-2.

technological advance and moving jobs to higher added-value and more knowledge-intensive areas.

Direct Financial Support

Direct financial supports have been the principal mechanisms used by European governments to assist their commercial aircraft manufacturers. This support has taken the form of government contracts for-the development of commercial models (in effect, grants), loans and loan guarantees on favorable terms covering both development and production costs, guarantees against losses caused by exchange rate changes, equity infusions, tax breaks, debt forgiveness, and bail outs. Without these supports, it is likely that no European firms would be in the large commercial aircraft manufacturing business.

Beyond simply enabling companies to operate at a loss, government financing has several benefits over commercially available financing. Governments, unlike commercial lenders, will finance specific projects. This enables manufacturers to move quickly to fill market openings with new models even when the cash flow from previous models is insufficient to convince banks to lend. This may give the manufacturers ahead start on their competitors, and because of the steep learning curve of this industry, a head start is an important advantage. Ideally, by getting into the new market first, the firm will be able to deter the entry of any competitor and so be able to establish a monopoly position.[66] Also, since government funding is usually provided during the development phase and paid back as a levy on sales, the government assumes much of the risk if sales are poor. This encourages companies to shift as many costs as possible to the development phase. For example, adopting advanced manufacturing methods and higher levels of automation in the production process may increase development costs but decrease production costs. Similarly, use of more advanced product technologies may increase development costs but reduce operating costs to airlines. Since the government bears the risk for the development expenses, companies are encouraged to make the most advanced aircraft in the most advanced way possible.

Before Airbus, British, French, and German jet transport manufacturers had launched 8 different models of jet transport of which only 2 sold more than 200 (total sales of 239 and 279),2 sold between 100 and 200 (total sales of 112 and 117), and the other 4 were catastrophic failures (total sales of 14, 11, 54, and 10).[67] Judging by the experiences of Douglas (driven to bankruptcy even while its planes were selling well), Lockheed (driven to bankruptcy by the L-1011, which ultimately sold 249 units), and Convair (driven from the commercial aircraft business by the 880/990, which sold 102 units), any one of these European ventures should have forced its manufacturers into bankruptcy, or at least from the commercial aircraft business. However, not one of the firms responsible for any of these aircraft has left the field, though some have been consolidated.

The ability of these firms to launch further aircraft models after their failures with previous designs is directly attributable to government intervention. From 1945 to 1974, the British Government spent £1,504 million at 1974 prices ($9.3 billion inflated to 1991 values) in launch aid for civil projects, including the Concorde, and were repaid less than £150 million ($929 million inflated to 1991 values) of that. The total cost of jet transport programs to the British Government rises to several times that amount if the cost of bailouts is included. From 1962 to 1977, the French Government spent an average of $829 million (at 1991 values) per year on civil projects, during that period repayments averaged only about $23 million per year.[68] Costs to the German Government were lower, as they had no part in the Concorde project, but Germany had other costly failures. Not only has government funding made European prime assemblers more competitive in international markets, at the supplier level it has made companies more desirable partners for U.S. firms looking to share the burdens of launching expensive, risky projects. Government support of the European partners made European participation in ventures like the CFM-56 and V2500 much more appealing for U.S. firms.

Because of Airbus, direct financial supports have come more into the international limelight, including a formal GATT complaint from the United States in early 1991. Most of the support the British, French, and German (and Spanish) Governments have provided to their aircraft manufacturers has been in the form of launch aid,[69] although the British Government has been more hesitant in this regard than the French and German Governments.[70] As of the end of 1989, the governments of France, England, and Germany had disbursed a total of $5.4 billion to the Airbus member companies in launch aid. Of this, roughly $500 million had been repaid.[71] Repayment of the remainder has been either forgiven or deferred, or was never intended. An additional $2.3 billion had been pledged for the A330/A340, and the German Government had committed a further $3 billion as part of the Daimler-MBB merger.[72] This government financing represents almost 75 percent of the development funds required for the Airbus models developed to date. As table 8-3 shows, as of the end of 1990, the $5.6 billion would have been $10.7 billion if the governments had charged firms the cost of the funds at rates the government themselves have to pay for

Table 8-3-Launch Aid for Airbus Members[a] (In $ billions)

	A300 & A310			A320			A330 & A340		
	France	U.K.	FRG	France	U.K.	FRG	France	U.K.	FRG
Commitments	1.2	0.1	3.0	0.7	0.4	0.9	0.8	0.7	1.6
Disbursements	1.1	0.1	1.5	0.7	0.4	1.0	0.3	0.3	0.3
Value at government[b]	3.3	0.3	3.1	1.2	0.6	1.1	0.3	0.4	0.3
Value at corporation[c]	7.5	0.3	5.7	1.8	0.7	1.2	0.4	0.4	0.3

	Program totals[d]			Country totals			
	A300 & 310	A320	A330 & 340	France	U.K.	FRG	All Airbus
Commitments	4.3	2.0	3.2	2.7	1.2	5.5	9.5
Disbursements	2.7	2.1	0.8	2.1	0.8	2.8	5.6
Value at government	6.7	2.6	1.1	4.8	1.3	4.7	10.7
Value at corporation	13.3	3.7	1.0	9.6	1.3	7.1	18.0

a~hese figures represent all launch aid and include funds alloted to non-Airbus aircraft projects such as the French ATR 42 and 72. Officials in France, Germany, and England state that the numbers are accurate. Neither firms nor governments in Europe disclose public supports at a level more detailed than those used here, so it is impossible to tell by how much the table overestimates the Airbus aid. Since Airbus is by far the largest aircraft venture currently receiving public financing in Europe, it is likely these figures overestimate the total Airbus launch aid by only a little.

bValue of the disbursed funds as of Dec. 31, 1988, including interest accrued assuming government rates (IO-year T-bills). The effects of staggered disbursements and loan repayments during the course of the programs have been factored in, and end-of-1988 currency exchange rates used.

cValue of the disbursed funds as of Dec. 31,1988, including interest accrued assuming corporate prime rates. The effects of staggered disbursements and loan repayments during the course of the programs have been factored in, and end-of-1988 currency exchange rates used.

dThe development costs of Airbus' most recent launch, a stretched version of the A320 designated the A321, are being financed without government assistance. The A321 was financed on commercial terms with a line of credit from the Euro Investment Bank. The financing was not project based but rather based on AI's credit standing as backed by the liability of the members under the GIE structure. The A321 thus represents not only the first time a new or derivative Airbus model was launched without government aid, it is also the first time that AI and not the members arranged the financing.

SOURCE: U.S. Department of Commerce, unpublished data collected from publicly available data.

borrowed money, and $18.0 billion if the firms had had to pay a corporate prime rate.

In addition to launch aid, the German Government (though not the French or British Governments) has provided its commercial aircraft manufacturers with loans to cover losses incurred during the production phase of Airbus projects. In 1988, the German Government paid off the outstanding production-phase debt its aircraft manufacturer had accumulated in the A300/310 projects so that no more interest charges would accumulate. Accumulated capital and interest had reached $1.05 billion.[73] Further, the German Government agreed in 1988 to guarantee against losses caused by the exchange rate falling below 1.8 DM to the dollar. Analysts estimate the government's maximum liability for the guarantees through 1996 is $1.3 billion and for the period from 1997 to 2000 is $863 million.[74] With exchange rates at levels (as low as the 1.5 DM to the dollar since the guarantee began, around 1.7 in mid-1991), the German Government is likely to have to pay nearly the full amount of the guarantee. Finally, at various times all of the Airbus members were government owned; Aerospatiale and Construziones Aeronautics S.A. (CASA) still are. Some of the equity bought by the governments constitutes a further subsidy.

Government Influence Over Airline Procurement Decisions

European governments have also created benefits for their commercial aircraft producers by influencing the procurement decisions of domestic airlines. Government ownership of airlines, close relationships between high-level officials and airline executives, and regulatory clout combine to give European governments sufficient influence to swing airlines' choice of manufacturers. (Table 8-4 shows government ownership of major European airlines.)

Examples of government intervention in procurement decisions are numerous. The British Government directed British European Airways to buy the British-made BAC 1-11 and British Overseas Airways to buy the VC-10 in the 1960s and 1970s. All of British Airways' current fleet uses Rolls Royce engines. The French Government pressured French airlines to buy the French-made Caravelle, and Air Inter, France's domestic airline, was the only airline ever to buy the short-lived Mercure. The French Government tried to force Air France to buy DC-9s instead of Boeing's 737s in order to help negotiations between McDonnell Douglas and Dassault over the proposed Mercure 200. The French Government succeeded in forcing the airline to buy GE engines instead of Pratt & Whitney engines for the

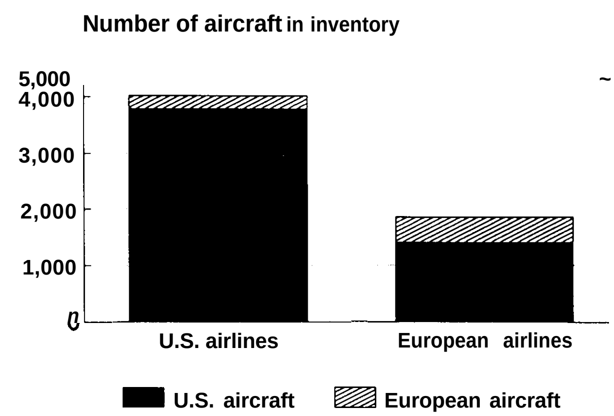
Table 8-4--Government Ownership of Major European Airlines

Airline	Country	Government ownership
British Airways	Great Britain	O% (100% until 1987)
Air France	France	Almost 100% (previously private UTA bought in 1 990)
Lufthansa	Germany	52% (72% in 1987)
Iberia	Spain	Almost 100%
Sabena	Belgium	Almost 100% (trying to privatize parts)
KLM	Netherlands	34% (declining from over 70% in early 80s)
Alitalia	Italy	100%
Swiss Air	Switzerland	NA
SAS	Scandinavian	100% (Sweden, Norway, and Denmark)

NA-not applicable.

SOURCE: County NatWest Bank.

Figure 8-4-Aircraft Inventories by Nationality of 'Airlines and Aircraft Manufacture, 1989



SOURCE: Boeing, World Jet Airplane Inventory, 1989 year end, 1990.

A31O because of GE's close ties to the French engine-maker SNECMA. Overall, the preference of European airlines for Airbus planes is pronounced, as figure 8-4 shows. In the categories where U. S.-made and Airbus aircraft compete directly, both Air France and Lufthansa have only Airbus planes in their inventories.[75] In fact, the willingness of national airlines to buy Airbus planes was an essential part of the original agreement by which Airbus was established.[76]

The significance of government-steered procurements has come less from the total volume of these orders than from their timing. French, British, and German airlines have provided the key launch orders, without which few of Europe's commercial aircraft programs would ever have proceeded. Without these orders, no Airbus models would likely have been launched.

The preference the Airbus members have shown for sourcing domestically has also been effective at promoting the development of a European supplier industry and at convincing U.S. manufacturers to transfer workshare and technology to European suppliers in return for access to Airbus contracts. During the selection of engines for the A300, Pratt & Whitney offered European firms subcontracts, but GE offered SNECMA and MTU a full partnership, giving them 16 and 10 percent respectively of the workshare of GE's CF-6-50 engine, and a say in the program's management. This offer was sufficient to convince the French and German Governments to specify the GE engine for the launch of the A300. Again, in the A31O engine competition, the GE partnership with SNECMA convinced the French Government to override Air France's preference for Pratt & Whitney engines.[77] This selection led to GE's and SNECMA's 50/50 venture to build the CFM-56 engine, which is now used on the A320. Needless to say, Air France has specified the CFM-56 for all of its A320s.

Government Promotion of Cooperation and Consolidation

European governments have also tried to improve the competitiveness of their aircraft manufacturers by promoting domestic consolidation and intra-European cooperation. European planners believe that to compete internationally in this industry, bigger companies are better. Domestic competition is seen as inefficient and has been sacrificed willingly to form larger firms better able to compete with American rivals. In England, France, and Germany, the dozens of aircraft companies that emerged from WWII were gradually consolidated into one commercial airframer and one commercial engine maker in each country. Consolidation at the supplier level followed. Competition within Europe has been discouraged in favor of cooperation, leading to a string of multinational ventures.

The rise of intra-European cooperation is an extension of the desire to achieve economies of scale that motivated consolidation within countries. The Concorde was the frost major collaborative civil project, followed by the ill-fated VFW-614 project between MBB and Fokker. Civilian collaboration really took off, however, with Airbus. Collaboration in military aircraft ventures is even more common than in civil projects. The Transall and the Tornado have been the biggest to date. Currently over 70 percent of Deutsche Aerospace's turnover is derived from collaborative projects, a proportion that is likely to rise to 80 percent by the end of the decade.[78] Though it is impossible to know exactly what the competitive benefits of all this consolidation and cooperation have been, European policymakers seem well satisfied by the results.

Military-Commercial Synergies

In addition to all the benefits described above, European manufacturers have profited from synergies between their military and commercial businesses, from funding of civil aeronautical R&D, and from export assistance much as U.S. companies have.

Examples of military/civil synergies in Europe are numerous. Rolls Royce's early engines, the Avon, the Olympus, and the Spey, all began as military engines.[79] Among Rolls' current commercial engines, none has a direct lineage in a military predecessor, but strong military R&D programs and sales, especially to the Middle East, contributed to Rolls Royce's recent recovery in the commercial engine business. SNECMA has benefited from combined civil and military sales of the CFM-56 just as GE has.[80] GEC of the United Kindom is developing a heads-up-display (HUD) combined with an infrared sensor to create a so-called ' 'synthetic vision system" for use on commercial aircraft. The needed technologies came out of military developments for night flying.[81] The Transall military transport collaboration between France and Germany ran from the late 1950s until the early 1970s and provided both specific technical synergies and broader business synergies with the commercial sides of the companies involved.

Some differences between the European and U.S. defense businesses affect the ability of commercial aircraft manufacturers to realize benefits from their military work. On the negative side, European governments have spent less on military aircraft than the U.S. Government, and military R&D has been a lower percentage of procurement, creating fewer opportunities for spillovers to the commercial side of the business. Duplication of R&D among various countries, each wanting to maintain autonomous defense production capabilities, has led to inefficient use of total European military R&D funds, resulting in fewer opportunities for commercial spin-offs than if the countries' R&D programs had been coordinated. European governments have spent less on the development of bombers, tankers, and military transports, which generate the most benefits for commercial aircraft.

On the positive side, European military exports are a greater percentage of total military production, partly compensating for lower domestic sales. Further, a higher proportion of the funds spent on military aircraft in Europe go to the same companies that build commercial planes than in the United States, which has many dedicated military contractors. As table 8-5 shows, total military production of all the Airbus members (excluding the rest of Daimler-Benz) is comparable to that of Boeing and McDonnell Douglas, and the reliance of these firms on military sales is higher than Boeing's, though not quite as high as McDonnell Douglas'.

European governments have mostly paid to develop military aircraft domestically rather than licensing from the United States. This practice has generated more commercially useful design and development capabilities than licensed production. The generally close relationships among European governments and their aircraft manufacturers create an atmosphere of trust in which companies are given substantial flexibility in the organization of their military work, leaving them more free than U.S. companies to achieve possible commercial-military synergies.[82] Consolidation has left most countries with only one manufacturer in each product category, which increases the bargaining power companies have in concluding contracts with their govern-

Table 8-5-Revenues From Military Aircraft and Related Sales, 1989

Company	Military sales[a]	Percent of total
MBB	783	47.0
Aerospatiale[b]	1,335	33.5
British Aerospace	3,470	53.6
All Airbus	5,588	46.1
Boeing	4,361	23.4
McDonnell Douglas	5,919	55.5

[a]In dollars.
[b]Includes some nonmilitary government sales.

SOURCE: Company annual reports.

ments. This may enable firms to achieve higher profits on military work, and those funds may then be used to finance commercial programs.[83] Finally, most of the European companies interviewed for this study appear to do as well or better than U.S. firms at combining military and civil overhead functions, reducing costs.

Government Funding for Civil Aeronautical R&D

Civil aeronautical R&D in Europe is similar to that in the United States. The Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt (previously DFVLR, now DLR) in Germany, Britain's Royal Aircraft Establishment (RAE) and the Office National d'Etude et de Recherches Aerospatiale (ONERA) in France all perform functions similar to NASA's aeronautics program.[84] They supply some of Europe's largest, most expensive research and test facilities and conduct research in areas in which firms would otherwise underinvest. These activities generate some competitive benefits for European firms, but the benefits are limited by the same difficulties NASA faces. Also, their combined aeronautics budget is smaller than NASA's, and redundancy among the three organizations reduces their effectiveness. The prospects for increased cooperation are good. While the benefits to European manufacturers of government-funded technology programs are unlikely to equal those for U.S. manufacturers, at least they are likely to increase from the level they are at now.

Export Assistance

Finally, European governments have helped their aircraft manufacturers export. In Europe, as in the United States, export financing has become much less important in the last decade than it once was. However, before the Large Aircraft Sector Understanding (LASU) agreement and the improvement of commercially available export financing, European governments helped aggressively. Until the late 1970s, Airbus sold so few planes that each sale was critically important. One order could represent a year's production. These circumstances drove Airbus to offer extreme deals to win orders. Even now, U.S. companies claim Airbus can offer better deals than they can because of the government support the members receive. European governments are also involved in providing offsets as sales incentives, whereas the U.S. Government refuses to become involved in such practices. Desirable landing rights for purchasing countries' airlines and development assistance to poorer countries are the most commonly cited examples.

Overall, Airbus deserves credit for the technical excellence of its aircraft and its improvements in production efficiency and product support. However, the importance of direct financial supports, other direct supports, and indirect benefits such as civil/military synergies are so great that it is fair to say that Europe has bought itself an aircraft industry.

CONCLUSIONS

The principal lesson of this study is that, for governments that believe some industries are more important to national welfare than others, many tools are available to speed the development of those industries. Some of the means of promoting development described here are expensive, and the task of weighing the cost of acquiring the desired industry against the benefits derived must be done carefully. In many cases, government supports have undesired side effects that undermine the intended positive effects. However, others cost little and all that is required of a government is the will to employ them. Sometimes, actions the government would take anyway naturally help the competitiveness of a desired industry, and all that is needed is that the government not prevent the benefits from accruing. Without doubt, effectively supporting an industry is difficult. However, as the world's aircraft industries show, it is possible.

1 This report discusses only England, France, Germany, Japan, and the United States. Brazil, Canada, Indonesia, Sweden, the Netherlands, Italy, Spain, and Belgium all support their commercial aircraft industries, not to mention the Soviet Union and China.

2 In this chapter, the term "commercial aircraft industry" is applied only to the part of the industry that produces large (over 100-seat) commercial jet aircraft.

3 Some of the foreign government actions described in this chapter could be deemed to violate the basic GATT treaty, one or more of the GATT codes (including Subsidies, Procurement and Aircraft), and/or other treaties related to international trade. This chapter does not address these issues.

4 The government actions included in this discussion are not intended to be a comprehensive list of all the many government actions that affect the competitiveness of commercial aircraft manufacture. Environmental regulation, education, labor policies, and macroeconomic policies, to name just a few, affect firms' competitiveness. This study focuses on actions that are most specific to the aircraft industry.

5 The launch decision is of special interest because it is at this point that government intervention can have the greatest impact. Inability to muster the resources to launch new models will ultimately force a manufacturer to exit the market. Further, at the time of the launch decision, many smaller technical and financial decisions are made that

will bind the manufacturer for decades.

6 Companies do not provide program-based financial data, but most industry analysts agree four programs have passed break-even, one is currently around that point, one is getting near, and the rest are not even close. The figures count derivatives as part of the same program. Some of the planes have been introduced only recently and may yet be profitable before their production is terminated.

7 Wolfgang Demisch, Christopher Demisch, and Theresa Concert, *The JetlinerBusiness,* First Boston Corp., Oct. 5, 1984, p. 4.

8 Unlike most products, where a belief in the presence of a market is sufficient to justify a product launch, commercial aircraft manufacturers require commitments from the customers before development begins. As a Boeing official pointed out, "one of the strangest features of this industry is that the manufacturers don't launch new products, the customers do."

9 Office of Science and Technology Policy, Aeronautical *Research and Technology Policy, Vol. 11: Final Report,* November 1982, p. C-49.

10 Irene L. Sinrich, "AirbusversusB oeing (A): Turbulent Skies,'' Harvard Business School case 9-386-193, in David B. Yoffie (cd.), *International Trade and Competition: Cases and Notes in Strategy and Management (New* York, NY: McGraw-Hill Publishing Co., 1990), p. 334.

11 Artemis March "TheUS Commercial Aircraft Industry and Its Foreign Competitors," *Working Papers of the MIT Commission on Industrial Productivity,* vol. 1 (Cambridge, MA: The MIT Press, 1989), pp. 11-12.

12 National Research Council, *The Competitive Status of the U.S. Civilian Aviation Manufacturing Industry: A Study of the Influences of Technology in Determining Industrial Competitive Advantage* (Washington, DC: National Academy Press, 1985), p. 25.

13 OSTP, op. cit., p. 1-11,

14 Among civilian manufacturing industries, the aircraft industry is by far the greatest beneficiary of government technology policy. Outside manufacturing, agriculture and health are also major beneficiaries of government R&D.

15 OSTP, op. cit.

16 From 1928-34 the airline industry was supported by subsidy payments for carrying the U.S. airmail (e.g., the Kelly Act of 1928 and the Watres act of 1930). At that time, the aircraft manufacturers and the airlines that bought their products were parts of the same companies, enabling the parent corporations to channel benefits of the government subsidies from the air carriers to the manufacturers. In 1934, the subsidy system was ended, with the airmail contracts put out for bid at much lower prices. OSTP, op. cit., pp. I-22-23.

17 Calculated from figures presented in Aerospace Industries Association, *Aerospace Facts and Figures, 1990-1991* (Washington, DC: 1989), pp. 19, 121, 123, and 127.

18 John Newhouse, *The Sporty Game (New* York, NY: Alfred A. Knopf, 1982), p. 113.

19 The fact that military work does not operate on the same cycles as the rest of the economy has not resulted from a conscious effort of government planners, but has nonetheless been important when it was coincidental. Most recently, the slowdown in commercial orders of the early 1980s coincided with the Reagan defense buildup. However, in the early 1970s, when down-turns in both sides of the business coincided, the industry was devastated.

20 Wolfgang Demisch, Managing Director, UBS Securities, personal communication, Sept. 11, 1990.

21 David C. Mowery, *Alliance Politics and Economics: Multinational Joint Ventures in Commercial Aircraft* (Cambridge, MA: Ballinger Publishing Co. 1987) p. 39.

22 DoD's regulations were adopted in response to a number of public needs that have often been at odds with the needs of increasing competitiveness and reducing costs. Among these are control of defense contractors by the government, maintaining fairness and competition in contract awards, ensuring against fraud or excessive profits at taxpayer expense, and protecting the interests of minorities, small business, and constituent groups. See U.S. Congress, Office of Technology Assessment, *Holding the Edge: Maintaining the Defense Technology Base,* OTA-ISC-420 (Washington, DC: U.S. Government Printing Office, April 1989), p. 10.

23 "In order to conduct (the billions in DoD procurement each year) the government has its own set of procurement rules, the Federal Acquisition Regulations, or FARs. Defense firms organize themselves structurally and especially administratively, to conform to these regulations, which often in-es costs relative to commercial projects. Compliance with the FAR is one of the factors that splits U.S. industry into two sectors." U.S. Congress, Office of Technology Assessment, *Arming Our Allies: Cooperation and Competition in Defense Technology,* OTA-ISC-449 *(Washington DC:* U.S. Government Printing Office, May 1990), p. 81.

24 This report does not analyze Pentagon procurement practices. Other OTA reports, including*Holding the Edge and Arming Our Allies,* op. cit., provide information on this topic. Briefly, Pentagon rules may require quality inspections so detailed and so frequent that they interfere with the ability of firms to produce efficiently. DoD specifications may demand exotic features or extreme performance that radically increase costs (the last few percent of improved performance often increases the total cost by a much larger percent). Finally, DoD specifications often detail not only the performance of the finished product, but also the processes that must be used in its manufacture, preventing the contractor from taking innovative steps to improve quality and reduce costs.

25 NRC, op. cit., pp. 117-118.

26 Though NASA claims credit for the development of the supercritical wing, earlier airfoil work that contributed to the breakthrough was conducted in the United Kingdom. OSTP, op. cit., pp. VII-81-82.

27 The technology was transferred by GE as part of the partnership agreement.

28 John S. Langford, *The NASA Experience in Aeronautical R&D: Three Case Studies With Analysis,* IDA Report R-319 (Alexandria, VA: Institute for Defense Analysis, March 1989), p. 79.

29 European observations of NASA's impact on competitiveness bear out this point. An official in the aircraft industry division at Britain's Department of Trade and Industry feels that their system of direct financial supports is a ''poor man's support" compared to R&D support. He thinks that governments (for whom promoting competitiveness is a priority) get far more bang-for-the-buck from direct subsidies than from R&D support.

30 Daniel Todd, Jamie Simpson, and Ronald Humble, *Aerospace and Development: A Survey (Winnipeg,* Canada: Department of Geography of the University of Manitoba, 1985), p. 14.

31 Mowery, *Alliance Politics and Economics*, op. cit., p. 39.

32 Postmaster General Harold Brown exploited his powers to "develop a small number of financially strong, transcontinental carriers who would provide a strong market for larger, more comfortable passenger transports." David Mowery and Nathan Rosenberg, "The Commercial Aircraft Industry,' in Richard R. Nelson (cd.), *Government and Technical Progress* (New York, NY: Pergamon Press, 1982), p. 141.

33 NRC, op. cit., p. 27.

34 Mowery and Rosenberg, op. cit., pp. 141-143.

35 A 1970 study comparing adoption of technical innovations between California's nonregulated airlines and the regulated "trunk" carriers showed that all but 2 of 40 aircraft types operated between 1946 and 1965 were first introduced by the regulated airlines. W.A. Jordan, *Airline Regulation in America* (Baltimore, MD: Johns Hopkins University Press, 1970), p. 55.

36 Standard and Poor's, "Aerospace Basic Analysis," p. A26 as cited in Barry Bluestone, Peter Jordan, and Mark Sullivan, *Aircraft Industry Dynamics: An Analysis of Competition, Capital, and Labor* (Boston, MA: Auburn House Publishing Co., 1981), p. 88.

37 These low bank rates may not persist. If the air travel market weakens and airlines find themselves with a glut of aircraft, the residual value of used planes may drop dramatically.

38 This document stated: "It seems realistic that the private sector should bear the ultimate risks involved in an aircraft development project, but for the time being, the government will subsidize projects on the condition that a percentage of the profits be contributed to the government, contingent on success. . . Development of aircraft engineering must be conducted on the initiative and assistance of the government as it involves highly sophisticated and complex technology." Ministry of International Trade and Industry, "The Vision of MITI Policies in the 1980s," pp. 291-292 as quoted in David C. Mowery and Nathan Rosenberg, *The Japanese Commercial Aircraft Industry Since 1945: Government Policy, Technical Development, and Industrial Structure* (Stanford, CA: The International Strategic Institute at Stanford, 1985), pp. 16-17.

39 Ministry of International Trade and Industry, "The Vision of MITI Policies in the 1980s," pp. 291-292 as quoted in Mowery and Rosenberg, ibid., pp. 16-17.

40 *Aerospace Japan Weekly,* June 11, 1990, This figure is likely to increase steadily with the growth of sales of recently introduced commercial aircraft and engines in which Japanese manufacturers are major participants. The commercial aircraft industry has failed to live up to MITI's early ambitions and has failed to keep pace with the rates of growth seen in other targeted industries.

41 Some Japanese manufacturers of components and subsystems, especially electronics and advanced materials, appear to have become competitive with their best foreign rivals.

42 David C. Mowery, "The Japanese Commercial Aircraft Industry: Deja Vu All Over Again?" paper presented at the meetings of the International Studies Association, London, Mar. 29-30, 1988, p. 7. Reports differ on the extent to which the Japanese Government assumed financial responsibility for the YS-11, though all agree that the government's share was substantial. See Richard W. Moxon, Thomas P. Roehl, and Frederick Truitt, *Emerging Sources of Foreign Competition in the Commercial Aircraft Manufacturing Industry* (Washington, *DC:* U.S. Department of Transportation, 1985), p. 122; Japan Economic Institute, "Japanese Industrial Policy with a Twist: Commercial Aircraft," report No. 39A (Washington, DC: 1983), p. 2.

43 Masao Kuno and Paul J. Rubin, "Japanese Aerospace—Aiming for the 21st *Century," Aerospace Japan,* November 1984, p. 64. Another source states debts accumulated as of March 1980 were only ¥7.1 billion. Koku Kikai Kogyo Shingikai (The Aerospace Advisory Committee), Konkai no Kokuki Kogyo Seisaku ni Tsuite: Daini Chukan Hokoku (Second Preliminary Report on the Future of the Aircraft Industry), Aug. 18, 1980, p. 16, as cited in Richard W. Moxon, Thomas P. Roehl, and Frederick Truitt, *Emerging Sources of Foreign Competition in the Commercial Aircraft Manufacturing Industry (Washington DC:* U.S. Department of Transportation, 1985), p. 122.

44 Richard J. Samuels and Benjamin C. Whipple, "Defense Production and Industrial Development: The Case of Japanese Aircraft," Chalmers Johnson, Laura D'Andrea Tyson, and John Zysman (eds.), *Politics and Productivity: The Real Story of Why Japan Works,* a research project of the Berkeley Roundtable on the International Economy (BRIE) (Cambridge, MA: Ballinger Publishing, 1989), pp. 309-310, note 6.

45 One MITI official stated that MITI has also made loans to aircraft manufacture to pay for tooling and that companies have to reimburse MITI for the depreciation.

46 Italy's national aircraft manufacturer, Aeritalia, also shared 15 percent of the development and manufacturing work on the 767. The 15 percent refers only to the value of the airframe and drops to about *7* percent of the total cost of producing the plane if components such as avionics and engines are included. JEI, op. cit., p. 5.

47 This system is also designed to insulate MITI politically by providing the financial assistance through intermediate organizations rather than directly from MITI coffers. Even so, MITI officials worry that the IADF may create dangers related to the General Agreement on Tariffs and Trade (GATT) negotiations currently underway between the United States and Europe, especially if the United States and Europe come to any substantive agreements over acceptable and unacceptable practices.

48 Officials of the Japan Aircraft Manufacturing Co., personal communication July 4, 1990.

49 Umezama Kyoji, "Nichi/Bei Kyodo Jigyo Taisei Naru" (The Japan-U.S. Cooperative Development Effort Forms)*Aerospace Japan,* January 1991, p. 31.

50 If calculated by the NATO standard method, which includes some expenses, excluded in the Japanese accounting method, such as pension commitments, the defense budget has ranged between 1.2 and 1.5 percent of Japan's GNP. Michael W. Chinworth, "Financing Japan's Defense Buildup," working paper of the MIT-Japan Program, December 1989, p. 8.

51 Yasuichi Arao (cd.), "Aerospace Industry in Japan, 1989-1990" (Tokyo: The Society of Japanese Aerospace Companies, 1989), pp. 30-31.

52 AIA, 1989-1990, op. cit., p. 21,

53 This does not include R&D conducted at the U.S. Department of Energy, most of which relates to nuclear weapons.

54 *Aerospace Japan* Weekly, Mar. 25, 1991, p.4. *and Budget of the United States Government: Fiscal Year 1992* (Washington, *DC:* U.S. Government Printing Office, 1991), Part I, p. 11, and Part II, p. 183. The official figures for Japanese military R&D appears to be substantially understated because some R&D expenses the firms undertake are later compensated in (and counted as) procurement. However, there is no doubt that R&D is a much bigger share of the U.S. defense budget than it is of the Japanese defense budget.

55 "Important Import," Aviation *Week and Space Technology,* Apr. 15, 1991, p. 11.

56 Michael Chinworth explains that "as a matter of policy TRDI emphasizes utilizing private sector resources to the greatest degree possible in order to minimize government expenditures and hasten the development of new technologies and products." See Chinworth, op. cit., p. 37.

57 Ministry of International Trade and Industry, Agency of Industrial Science and Technology, "National Research and Development Program (Large-Scale Project), 1989," brochure, March 1989, p. 5.

58 In 1990, MITI had available ¥133.5 billion to loan to Japanese aircraft manufacturers to purchase foreign aircraft, ¥72.7 billion from the JDB and ¥61.8 billion from the Japan Export-Import Bank. *Aerospace Japan Weekly,* Jan. 15, 1990, p. 8.

59 Samuels and Whipple, op. cit.; Johnson et al., op. cit., pp. 289-290.

60 For example, a recent article reports, "MITI does not want Toyota to enter the military aircraft market for the time being. But it is positive about Toyota's entry into the commercial aircraft market. Toyota itself seems to be well aware of MITT's intention. Toyota will concentrate its efforts in the commercial aircraft market for a while. " Aerospace *Japan Weekly,* Aug. 6, 1990, pp. 8-9.

61 Mowery, "The Japanese Commercial Aircraft Industry," op. cit., p. 19.

62 This section looks only at the governments and companies of England, France, and Germany. Within Europe, Holland, Italy, Spain, and Belgium also have substantial capabilities in commercial aircraft and component production, and the governments in these countries have

also been active in promoting the growth of their aircraft industries. The three countries dealt with here were chosen because they account for the bulk of Europe's aerospace production (88 percent of the total in 1988) and because they are the principal manufacturers of planes of the size dealt with in this study. Policy measures and the motivations behind them in France, England, and Germany are similar but not identical. This section will treat the government policies of all three countries together with differences pointed out as they arise, rather than presenting separate discussions for each. Commission of the European Communities, "The European Aerospace Industry, Trading Position and Figures, 1990," Directorate-General Internal Market and Industrial Affairs, Brussels, February 1990, p. 180.

63 Support for the aircraft industry also is a tool of regional development. Keith Hayward argues that this was the intent of French policy makers when they located substantial subcontracting work for commercial aircraft in Saint Naziere, then a depressed area of the country. France's main aircraftcenter, Toulouse, was a locus of aircraft construction before WWII, but the decision to concentrate aircraft production there after the war is also viewed as regional policy.

64 Richard Baldwin and Paul Krugman, "Industrial Policy and International Competition in WideBodied Jet Aircraft," Robert E. Baldwin (cd.), *Trade Policy Issues andEmpiricalAnalysis* (Chicago, IL: The University of Chicago Press, 1988)), pp. 68-69. Another study looks at the competition between all of Airbus' and Boeing's current products and concludes that an estimated $20 billion in Airbus subsidies buys a net welfare gain in Europe of $7.7 billion (including the cost of those subsidies) compared to a hypothetical U.S. monopoly but a net welfare deficit of $3.7 billion compared to a U.S duopoly. Gemot Klepper, "Industrial Policy in the Transport Aircraft Industry," paper presented at the Center for Economic Policy Research workshop on Strategic Trade Policy, Cambridge, MA, Oct. 13 and 14, 1989, p. 24.

65 A recent EC report on the aviation industry cited this reason (among others) why the aircraft industry is a valuable asset: "A strong aeronautics industry should be recognized at the highest levels as an essential element in the promotion of a European identity . . . [T]he existence of a European aeronautics industry in world markets. . . helps to spread the economic and cultural influence of Europe." *Euromart Study Report: Executive Summary,* a joint study of the European Commission and nine major European aircraft manufacturers, April 1988, p. 33.

66 Boeing accomplished this with the 747; for 20 years no company has challenged Boeing's position in this category. The early Airbus launch of the A320 was a major factor deterring Boeing from launching a direct competitor. Boeing's 2-year lead hinging out the 727 before Douglas' DC-9 was important in the eventual success of the 727, as was Boeing's l-year lead bringing out the 707 before the DC-8. Airbus' deliveryoftheA3008 years before Boeing's 767 was a principal reason Airbus was able to get a foothold in the commercial aircraft business at all.

67 Fokker of the Netherlands also launched a jet transport, the F-28 (which sold 241 copies and continues to sell as the updated F-1OO) and had a share of the VFW-614, a 50-seat short range jet that was canceled before any deliveries were made.

68 *Keith Hayward, International Collaboration in Civil Aerospace* (New York, NY: St Martfh's Press, 1986), p. 162. Converted using data from IMF, *International Financial Statistics Yearbook, 1989* and BEA's GNP deflators.

69 Launch aid generally covers only development costs. Plants and equipment that might be reused for future models are not usually included in development, but aircraft-specific hardware such as jigs and tooling usually are. For example, the $725 million British Aerospace got from the British Government to develop the A330/A340 wing will be used to fund not only the hardware development but also the flight testing and the cost of most of the tooling. March, op. cit., p. 18. Since development costs are the highest-risk portion of the total startup costs, government assumption of these costs is more valuable than government assumption of other costs. Nevertheless, launch aid covers only a portion of the investment needed to begin production of a new model. For example, the total financing needs for Aerospatiale's portion of the A330-340, is 7-8 billion French francs ($1.4-1.6 billion). Of this, the French Government financed 60 percent of the development costs, amounting to 30-35 percent of the total capital required. The rest was borrowed. Representatives of Aerospatiale, personal communication, Oct. 16, 1990.

70 Withthenationalization of BACand Hawker-Siddeleyin 1977, the British Government discontinued the practice of providing launch aid. Equity investment was used instead. However, when the newly formed BAe was privatized in 1982, it once again became eligible for launch aid under the provisions of the 1949 Civil Aviation Act.To give launch aid, the government must be convinced that a project would not go ahead without the government's support, that there is a reasonable chance that the government will recoup its funds, and that the project is in the national interest. It is worth noting that these criteria are nearly identical to those the Japanese Government usein deciding whether or not to provide *hojokin.* Keith Hayward, *Government and British Civil Aerospace* (Manchester, U.K.: Manchester University Press, 1983), pp. 196-197 and representatives of the Department of Trade and Industry, personal communication Oct. 8, 1990.

71 This is the Gellman Research associates estimate. Keith Hayward estimates that roughly $1 billion had been repaid by 1986. The *Economist* reports that, "Every time an Airbus A31O flies off to join an airline.. .$10m is paid back to the governments." Gellman Research Associates, "An Economic and Financial Overview of Airbus Industries, " Sept. 4, 1990, prepared for the International Trade Admintis tration, U.S. Department of Commerce, pp. 2-3, Hayward, 1986, op. cit., p. 52, and "Dissecting Airbus,'' *The Economist*, Feb. 16, 1991, p. 51.

72 Gellman Research Associates, op. cit., p. 2-2.

73 Keith Hayward, ''European Civil Aerospace," contractor report for the Office of Technology Assessment, November 1990, p. 69.

74 Gellman Research Associates, op. cit., pp. 2-11.

75 Air France has A300s, A 310s, and A320s, but no 757s or 767s. Air France does have some 737s and 747s, but Airbus makes no planes of comparable sizes to compete with these. Air France also has some old 727s, but these were bought before the equivalent Airbus aircraft had entered production.

76 Hayward, *International Collaboration in Civil Aerospace,* op. cit., p. 53.

77 To help compensate for the French Government's pressure on Air France to buy the GE/SNECMA engines for their A31OS, Pratt offered the following package: rebuilding the Pratt and Whitney engines on Air France's 747s at a value of $25 million, setting up anew engine maintenance shop at Charles de Gaulle airport, and providing direct offsets to French subcontractors of 30 percent of the value of the A31O engines (including those sold to other airlines) including turbine disc forgings, machine tools, and bearings. It was not enough. "Inside the Airbus Engine War," *The Economist*, Oct. 13, 1979, p. 81.

78 Hayward, "European Civil Aerospace," op. cit., pp. 23-24.

79 The Avon was developed for the Hunter military jet and was also used in the Valiant bomber. Commercially, the engine was used in later Comet models and the French Caravelle. The Olympus was developed for the Vulcan bomber and then was upgraded for supersonic use and adapted on parallel tracks for the TSR-2 bomber and the Concorde (though its adaptation for civil use proved more difficult than initially expected). The Spey *was* first developed for a number of " military aircraft, which were canceled in 1957. Rolls privatelyfinanced a civil version, which was used in the Trident, and the original military version was ultimately used in the British F-4s bought in the early 1960s. Keith Hayward, letter to OTA staff, Feb. 11, 1990, p. 7.

80 Since the CFM-56 program began, the U.S. Govemment has sometimes been a bigger SNECMA customer than the French Government.

81 "UK'S GEC Develops Airliner HUD," *Flight International,*

Oct. 31-Nov. 6, 1990, p. 17.

82 In contrast to the United States, where military aircraft manufacturers often state that DoD procurement rules hinder or prevent them from achieving synergies between their military and commercial products, all the European contractors interviewed for this study stated that they faced no such barriers. The government-owned firms pointed out that since any increased profits would only return to the government, the government would be silly to prevent firms from achieving synergies where possible. This close relationship between government and industry is more pronounced in Germany and France than in Britain.

83 For example, the British Ministry of Defense (MoD) has difficulty exercising cost control over Rolls Royce since there is no domestic alternative source of supply. Rolls Royce officials state that MoD has threatened to shift procurement contracts to U.S. suppliers but has never actually done so (though one small service contract was shifted to a U.S. competitor). Representatives of Rolls Royce, personal communication Oct. 10, 1990. The inability of the MoD to wield a credible threat of removing work from Rolls Royce plants may enable Rolls to generate higher profit margins on MoD contracts than U.S. companies can. These higher profits from military production could be used to hold down commercial prices or to fund higher levels of R&D.

84 The RAE and ONERA are funded from defense budgets while DLR is funded from civil sources.