INTRODUCTION

To analyze the implications of a globalizing U.S. defense aerospace industry for the Air Force, we must first address two questions:

- What do we mean by “globalization”?
- How globalized is the U.S. defense aerospace industry?

In the ongoing debate over how to define globalization, some observers make a clear distinction between the process of becoming a “global” industry and that of becoming merely an “international” one. For example, Frankenstein (1996) argues that a truly global company has design, manufacturing, and marketing capabilities in multiple locations around the world, while an international company buys components and markets products abroad but locates its primary design and manufacturing capabilities in its home country. According to this view, increases in cross-border trade flows might indicate the “internationalization” of an industry, but there must be deeper business relationships between domestic and foreign firms before it can be described as “globalized.”

We take a broader view of globalization in this report, encompassing both “global” and “international” companies in our definition of what it means for the defense aerospace industry to be globalized. We believe a broad view is appropriate because even if trade were the only form of international activity in which defense aerospace firms
participated, it would still give rise to significant policy issues. Nevertheless, we recognize that the effectiveness of particular government policies in managing globalization will depend on the nature of that globalization. For example, policies designed to restrict the foreign outsourcing of widgets are unlikely to deal effectively with issues raised by U.S.-foreign collaboration on major weapon system development programs. Therefore, a key objective of this chapter is to review the available evidence not only on the magnitude but also on the character of U.S. defense aerospace industry globalization.

When defined broadly, the most visible manifestation of globalization can probably be found in the growing cross-border purchase and sale, by number and by value, of goods, services, and financial assets. We know from widely available aggregate data on international trade and investment that according to these measures, the U.S. economy at the start of the 21st century is more globalized than ever before (Council of Economic Advisers [CEA], 2000). Unfortunately, the changes in the nature of international business relationships and activities that have almost certainly accompanied this increase in cross-border trade and investment are hard to track, primarily because there are so few data sources that capture them. There are no widely accepted definitions for many of the terms used to describe them.

Nevertheless, recent studies of defense companies by Bitzinger (1999) and GAO (2000c) indicate that global linkages among defense firms are becoming deeper and more complex. Our own case study evidence—which uses a typology of cross-border relationships and activities common to the defense aerospace industry—suggests that aerospace firms, too, are responding to the imperatives of globalization by creating innovative cross-border business structures.¹ What these new structures may imply in terms of Air Force objectives for the defense industrial base, however, is not yet well understood.

Finally, the increasingly multinational character of the U.S. industrial workforce is also an important feature of globalization, although it is not always recognized as such because of a severe lack of data. One

---

¹See Chapter Five for a discussion of these cases.
source of information is the National Science Foundation’s biennial Survey of Doctorate Recipients (National Science Foundation, 2001). This survey indicates that of roughly 630,000 U.S.-trained doctoral scientists and engineers in the United States in 1999, just over 10 percent were non–U.S. citizens. In the field of aerospace/ aeronautical engineering, however, non–U.S. citizens constituted 13.7 percent of doctorate holders, while the proportion of non–U.S. citizens who held doctorates in information sciences was 27.3 percent. Unfortunately, these data provide no insight into the number of foreign-born scientists and engineers working in the United States who did not receive degrees from U.S. universities, and they cannot tell us how many are employed in the military aerospace industrial base. We therefore do not pursue them further in this report. Nevertheless, the fact that the military aerospace industrial base, like the United States as a whole, relies to a significant extent on noncitizens to fill highly skilled technical positions may have important implications for U.S. national security.

DEFENSE AEROSPACE GLOBALIZATION: DATA SOURCES AND TERMINOLOGY

Defense Aerospace Trade

There is little statistical data specific to the production and consump- tion of or trade in defense aerospace systems and subsystems—or at least little at useful levels of disaggregation. Nevertheless, several sources do provide data that shed light on the extent of trade-related globalization of the defense aerospace industry. Each source has its own strengths and weaknesses, but the perspectives they provide fall into three major categories:

---

2The survey covers all persons under the age of 76 who hold a doctorate in science or engineering from a U.S. institution, where “science” includes the social sciences and psychology as well as the physical, information, and mathematical sciences.

3For comparison purposes, the U.S. Bureau of the Census estimates that the proportion of non–U.S. citizens in the total U.S. population was 6.5 percent in March 2000 (U.S. Department of Commerce, Bureau of the Census, 2000).

4As far as we know, no comprehensive DoD databases relevant to these issues exist.
• Production, consumption, and international trade in aerospace products, both civil and military (e.g., the U.S. Department of Commerce’s International Trade Administration [ITA] and the Aerospace Industries Association [AIA]);\(^5\)

• The production and international transfer of conventional armaments, including both aerospace and nonaerospace equipment (e.g., DoS, the International Institute for Strategic Studies [IISS], and the Stockholm International Peace Research Institute [SIPRI]);\(^6\)

• Government expenditures on and procurement of products and services related to national defense (e.g., AIA, DoS, IISS, NATO).

The data on aerospace products have the advantage of being specific to aerospace while also distinguishing between finished (or “complete”) products and production inputs.\(^7\) This is important because a growing number of cross-border transactions involve the outsourcing of production inputs to unrelated foreign suppliers as well as shipments between the internationally located business units of the same firm (Hummels et al., 2001; Fernald and Greenfield, 2001). This vertical specialization of trade—or “intra-industry” trade—raises complex national security issues when applied to defense industries, but unfortunately breakouts for civil and military aerospace products are not always available. Shipment data, for example, distinguish between complete civil and military aircraft but not between civil and military engines or aircraft parts.

Another major problem with most aerospace data is that they capture only inputs formally classified within the “aerospace” categories of the U.S. Standard Industrial Classification (SIC) system or the

---

\(^5\)ITA and AIA provide data to each other; both also get data from the Bureau of the Census, U.S. Department of Commerce.

\(^6\)The Bureau of Verification and Compliance within DoS now issues World Military Expenditures and Arms Transfers. The U.S. Arms Control and Disarmament Agency, which has merged with DoS, issued previous editions.

\(^7\)Finished aerospace products include fixed-wing aircraft, helicopters, and space vehicles, while inputs range from commodity goods such as tubes, pipes, and hoses to more specialized equipment such as launching gear and gas turbine engines for aircraft. These data cover only merchandise goods, which is unfortunate because trade in engineering and other technical services is likely to be an important feature of aerospace industry globalization.
North American Industrial Classification System (NAICS). Commodity inputs such as many types of fasteners and hoses are not included. Even more problematic from a policy perspective is the fact that certain high-cost, high-technology inputs to the aerospace industry also cannot be analyzed using published ITA data. Radar, navigation, and guidance systems, for example, all fall within the non-aerospace-specific category “search and navigation equipment” and thus are not analyzed here.

The data on conventional arms production and transfers have the advantage of being specific to defense, and although they are not specific to aerospace, they are dominated by it. The three sources we analyze differ slightly in their coverage. SIPRI collects data on major conventional weapon systems that are voluntarily transferred from one country to the armed forces, paramilitary forces, or intelligence agencies of another country. Weapon systems cover complete aircraft, armored vehicles, artillery, radar systems, missiles, and ships. DoS and IISS add small arms, ammunition and other ordnance, uniforms, some dual-use equipment, and some military services to this definition but do not include the value of arms obtained by subnational groups. IISS’s figures for the United States derive from DoS, but its export figures are often higher because of generally higher estimates of U.S. direct commercial sales (IISS, 2000, p. 288). No data on trade in inputs to weapon system production are publicly available.

The data on aerospace production and consumption, defense expenditures, and government procurement provide a context for the trade and transfer data. Specifically, they allow us to establish the

---

8 The NAICS formally replaced the SIC system in 1997.
9 According to SIPRI (2000), for example, eight of the world’s top ten arms-producing companies ranked by 1998 sales were involved in the production of aircraft or missiles or both.
10 As described in a report by SIPRI (2001), “This includes weapons delivered illegally—without proper authorization by the government of the supplier or recipient country—but excludes captured weapons and weapons obtained through defectors.” SIPRI data are obtained from open sources rather than directly from governments.
11 See DoS (April 2000, p. 205) for a fuller description of the items these two sources define as conventional arms.
significance of foreign suppliers and markets relative to U.S. suppliers and markets for U.S. defense aerospace firms.

The sources for data on aerospace products use standard definitions of merchandise exports and imports: Exports are shipments to and imports are shipments from firms or units of firms located across a national border, including both complete products and intermediate inputs. The nationalities of particular buyers and sellers are irrelevant; for example, U.S. exports consist of all shipments from the United States to destinations outside the United States, and U.S. imports are all shipments to the United States from sources outside the United States. The sources for conventional armament data generally refer to “transfers” and “deliveries” rather than to “trade” and “shipments” because they include aid and gifts as well as commercial sales (SIPRI, 2001). The terms “export” and “import” are sometimes used with respect to arms transfers, but these data do not capture all cross-border sales related to the weapon industry. Rather, they capture the narrower set of finished-product transactions that involve suppliers and recipients of different nationalities.

A distinguishing feature of international trade in defense aerospace is that so much of it is governed by “offset” agreements—that is, by conditions negotiated by foreign governments with U.S. companies seeking to export major systems to their countries (Presidential Commission on Offsets in International Trade, 2001). Common types of defense offset transactions, which are almost always designed to benefit national firms in the recipient country, include the following:

- Subcontracts related to the manufacture and assembly of system parts and components;
- Licensed coproduction of the system;
- Counterpurchases of unrelated goods;
- Related or unrelated technology transfers and training;
- Related or unrelated credit transfers; and

\[\text{---}\]

\[\text{12 Much less is known about the nature and extent of commercial, as opposed to defense, offsets because there is no government requirement for reporting them.}\]
• Related or unrelated investment.

According to data collected by the Commerce Department’s Bureau of Export Administration (BXA), between 1980 and 1998 the value of defense offset agreements ranged from 34 to 98 percent of total defense export sales.\(^\text{13}\) According to the Presidential Commission on Offsets in International Trade (2001), 89 percent of defense offsets (measured by value) from 1993 to 1998 were associated with aerospace exports. Offset agreements complicate the analysis of defense aerospace industry globalization because they induce U.S. firms to engage in cross-border transactions in which they might not otherwise elect to participate. In particular, U.S. investment in foreign aerospace firms is likely to be larger than it would be were offsets not so prevalent. It is likely that U.S. aerospace exports benefit considerably from offset arrangements.

**Defense Aerospace Investment**

Statistical data relevant to the international investment activities and business relationships of U.S. defense aerospace firms are even scarcer than data on their cross-border trade. In this report, we make use of publicly available data from four sources:

- Economy-wide data on cross-border investment activity involving U.S. firms (e.g., the U.S. Department of Commerce’s Bureau of Economic Analysis [BEA]);
- Data on domestic and international M&As involving U.S. firms (Mergerstat);
- Data on foreign acquisitions of U.S. defense firms (Ciardello, 2001); and
- Data on U.S. industry involvement in defense acquisition programs worldwide (Bitzinger, 1999).

\(^{13}\)The “value” of defense offset transactions is measured as the amount of offset credit awarded to U.S. exporters by the nations receiving the offsets. It generally does not represent an actual cost to the exporter. See Presidential Commission on Offsets in International Trade (2001, pp. 6–8).
The first data source provides official U.S. government estimates of foreign direct investment in the United States and U.S. direct investment abroad, spanning all industries and sectors, including nonmanufacturing sectors such as agriculture and services. These data provide useful benchmark statistics to which the investment activities of defense aerospace firms may be compared, but the published industry breakdowns are too broad to offer any further insights.

The second source consists of privately collected data on domestic and international M&As involving U.S. firms. M&As, defined below, represent a subset of investment activities that have particular significance for the Air Force because they involve changes in ownership and thus control. Once again, the publicly available data from these sources are not specific either to defense or to aerospace, but they provide a useful benchmark.\(^{14}\)

Ciardello (2001) reports the number of foreign acquisitions, mergers, and takeovers reviewed by the Committee on Foreign Investment in the United States (CFIUS) under the Exon-Florio Amendment to the Defense Production Act of 1950. Exon-Florio requires that restrictions be imposed on foreign acquisitions, mergers, or takeovers that have the potential to threaten U.S. national security. Notification of proposed transactions to CFIUS is provided voluntarily by the parties concerned.\(^{15}\) Threats to national security are broadly defined to include threats to U.S. technology leadership as well as threats to the U.S. domestic industry’s capability and capacity to meet national defense requirements (see Chapter Four), but Ciardello focuses on cases that are defense-related.

Finally, the Defense Budget Project’s (DBP’s) Globalization Database, described in Bitzinger (1999), provides a perspective on defense-related cross-border investment that comes close to our own. Covering the period 1961 to 1995, the DBP database contains two types of information: a classification and listing of cross-border defense acquisition programs and activities, and a classification and

---

\(^{14}\)Mergerstat does offer limited data on aerospace-related M&A activity for a fee.

\(^{15}\)CFIUS member agencies may also refer proposed transactions to the committee that they perceive as posing a possible threat to national security (U.S. Department of the Treasury, undated).
listing of the types of cross-border business relationships that have been formed to carry out those programs and activities. Breakouts by system type—including aircraft and guided missiles—are provided. The database also distinguishes industry-initiated relationships from government-initiated arrangements in which firms of different nationalities share R&D and/or production responsibilities, usually in proportion to the financial contributions of their respective governments.

The U.S. Department of Commerce’s BEA as well as Mergerstat and Ciardello (2001) all use definitions that derive from U.S. government sources. According to U.S. official usage, for example, the term direct investment—which implies a degree of operational involvement in a firm’s operation—requires an ownership stake of at least 10 percent of the voting securities of an incorporated business enterprise or an equivalent interest in an unincorporated business enterprise. This quantitative criterion applies both to foreign direct investment in the United States and to U.S. direct investment abroad. By definition, a foreign affiliate is a foreign business in which there is U.S. direct investment; a U.S. affiliate is a U.S. business in which there is foreign direct investment. A majority-owned foreign affiliate has combined ownership by all U.S. parents of over 50 percent; the same percentage criterion applies to the U.S. affiliates of foreign parents.

Both internationally and domestically, one company’s establishment of a controlling interest in another company is called an “acquisition”; the company acquired is often called a “subsidiary.” In most cases, U.S. firms’ foreign subsidiaries are also technically their foreign affiliates and vice versa. In cases where 10 percent ownership does not confer a controlling interest, however, an affiliate is not also a subsidiary, and where less than 10 percent does, a

16Unfortunately, the DBP database does not always distinguish between these two types of information. Although the DBP database includes the cross-border activities of and relationships among a global spectrum of defense firms, we are interested only in those that involve U.S. firms.

17U.S. usage of investment vocabulary is not uniformly consistent with that of other countries. For an overview of key U.S. terms, see BEA (2000a, p. 58).

18In the United States, anything below the 10 percent threshold constitutes portfolio investment. In some other countries, however, foreigners must own 25 percent of the voting stock before their investment is termed “direct.”
subsidiary is not also an affiliate. In the case where a single company purchases 100 percent of another company’s voting stock, the company that has been taken over is called a “wholly owned subsidiary” of the purchasing company. A merger is a special type of acquisition in which two companies become one by exchanging shares. Measures of cross-border direct investment are usually larger than measures of cross-border M&As because the former include the continuing flow of equity, debt, and reinvested earnings between parents and their already established foreign affiliates.

While the term direct investment implies some degree of managerial control or operational involvement, it does not speak to the nature or intent of the business relationship that generated the investment. A 10 percent stake may allow a firm to create or participate in a variety of enterprises for a variety of reasons, ranging from a joint venture that targets a specific product to a wholly owned foreign subsidiary that targets an entire market segment. Further, there are many activities or programs, including simple cross-border trade, that could in theory be conducted within a particular business relationship.

Of special interest, therefore, is our fourth data source, the DBP Globalization Database, which lists international cooperative activities and business relationships formed specifically for the purpose of developing and/or producing major weapon systems and components. Unfortunately, this database does not contain financial or cost information on the programs it lists, and it does not always distinguish the activities of firms—such as selling the rights to one firm to assemble or manufacture a weapon system that a different firm has developed—from their relationships, such as that between a prime and its subcontractors or between the parent companies in a joint venture. As a result, the DBP database cannot be used either to compare the relative importance (by value) of alternative business arrangements and activities or to determine which types of business relationships have most often been associated with which types of activities. Nevertheless, as far as we know it is the only source that provides quantitative evidence of the increasingly “global” as op-

---

19Mergers between companies located across national borders often result in the creation of a wholly owned subsidiary in the home country of one of the original companies.
posed to “international” character of the U.S. defense aerospace industry.

A Typology of Defense Aerospace Activities and Relationships

To better understand recent globalization trends in the defense aerospace industry and the role played by legislation, policy, and guidance in shaping those trends, we have developed a typology that distinguishes between the joint or cooperative activities of firms located across national borders and the business relationships they establish in order to facilitate those activities. For our purposes, the most relevant activities carried out by U.S. defense aerospace firms are those shown in Table 2.1, which borrows terminology from the *International Armaments Cooperation Handbook* (Deputy Under Secretary of Defense for International and Commercial Programs, 1996). In brief, these are

- Cross-border shipments of platforms, systems, or major subsystems;
- Licensed coproduction;
- “Partnership” coproduction;  
- Foreign Military Sales (FMS) coproduction; and
- Codevelopment.

With respect to the export of finished equipment, an important issue is the extent to which system or subsystem subcontracts or other

---

20All of these activities can also include adapting, modifying, or upgrading existing complete or semifinished products.

21We use the term *partnership coproduction* as opposed to *cooperative production* in order to distinguish the former from other forms of cooperative production. Both terms are defined in Chapter 19 of the *International Armaments Cooperation Handbook* (Deputy Under Secretary of Defense for International and Commercial Programs, 1996, p. x).
26 U.S. Government Policy and the Defense Aerospace Industry

Foreign sale or purchase of complete or semifinished products (e.g., platforms, systems, or major subsystems)\(^b\)

Licensed coproduction

Licensed coproduction

FMS coproduction

Partnership coproduction

Codevelopment

| Activity | Description
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign sale or purchase of complete or semifinished products (e.g., platforms, systems, or major subsystems)(^b)</td>
<td>Often involves offsets arrangements with foreign companies.</td>
</tr>
<tr>
<td>Licensed coproduction</td>
<td>The commercial sale or transfer of rights to overseas FACO as well as varying degrees of component manufacturing of an aircraft or major subsystem originally designed and developed by one or more U.S. companies. May or may not be intended for both U.S. and allied inventories.</td>
</tr>
<tr>
<td>FMS coproduction</td>
<td>The sale or transfer of rights to overseas FACO as well as varying degrees of component manufacturing of a U.S.-designed and -developed aircraft or major subsystem under the terms of a formal FMS agreement. Generally applies to aircraft or subsystems in current U.S. inventory.</td>
</tr>
<tr>
<td>Partnership coproduction</td>
<td>Manufacture and assembly by at least one U.S. and one foreign company of part or all of a system or major subsystem originally collaboratively developed by those companies under a formal armaments cooperation program. (See “codevelopment.”)</td>
</tr>
<tr>
<td>Codevelopment</td>
<td>Joint design and development by at least one U.S. and one foreign company of part or all of a system or subsystem under a formal armaments cooperation program involving an international agreement between the United States and an allied country. Usually followed by partnership coproduction.</td>
</tr>
</tbody>
</table>


\(^b\)This is a much narrower definition than that for the term *trade*, which includes all cross-border movements of goods, including commodity items such as fasteners and other small parts.
offset agreements are involved. A key issue with respect to all of the activities is whether the equipment in question is intended for both U.S. and allied inventories, thereby furthering equipment standardization and interoperability objectives.

All three forms of coproduction involve the transfer of rights to final assembly and checkout (FACO) of U.S.-developed equipment to a foreign country. They are termed coproduction rather than production in order to emphasize their collaborative nature: Even for straightforward licensing arrangements, it has rarely if ever been the case that the developer of a system as complicated as a fighter jet has sold its FACO rights to a foreign company and simply walked away. Licensed coproduction differs from FMS coproduction in two key respects. First, licensed coproduction may or may not involve a system or subsystem that is in the inventories of the U.S. armed services, while FMS coproduction always involves articles used by the U.S. armed services. This distinction is important because it relates to the crucial question of equipment standardization and interoperability with U.S. allies. Second, licensed coproduction involves a direct commercial sale from the developer; FMS coproduction arrangements are negotiated under the terms of an FMS Letter of Offer and Acceptance (LOA) issued by the U.S. government. Thus, with FMS coproduction the U.S. government formally handles the details for procuring the equipment as an agent of the foreign government, thereby further promoting interaction and interoperability with an ally. Partnership coproduction is a special type of coproduction that represents the production phase of an international cooperative research, development, and acquisition (ICRD&A) agreement. The first phase of an ICRD&A agreement is commonly referred to as codevelopment. In partnership coproduction arrangements, FACO is generally carried out in both of the participating countries. Partnership coproduction thus implies a qualitatively more profound level of collaboration, since both R&D and production are shared among two or more allies.

These international collaborative activities can be supported by several different types of cross-border business relationships. As shown

---

22In cases where the offset required for the sale of a U.S.-developed system involves transfer of rights to overseas FACO, the activity is classified as coproduction and not as a cross-border shipment.
in Table 2.2, the most common relationships among defense aerospace companies fall into the following categories:

- Prime/subcontractor;
- Marketing agreement;
- Team;
- Joint venture; and
- Parent/subsidiary.

All of the relationships are also more or less common among domestic firms within a purely national context.

Prime/subcontractor arrangements are traditional business relationships found throughout many industries. Under these arrangements, the system designer/integrator (the prime contractor) hires other firms to manufacture—and, increasingly, to design and develop—particular subsystems and components. Primes possess final decisionmaking authority for the overall design, development, integration, and (usually) final assembly of the aircraft and are responsible for marketing the finished aircraft. Primes may choose to work with foreign subcontractors for a number of reasons, but market access considerations are often just as or more important to them than cost considerations. Much of the international trade in defense aerospace subsystems, parts, and components takes place between subcontractors and primes located across national borders.

In the international arena, marketing agreements represent a set of arrangements whereby a firm in one country acquires the right to market and distribute a system or subsystem developed by a firm in another country. International marketing agreements are often set up to allow foreign firms to access national markets in which legal and/or political conditions heavily favor domestic firms. These types of agreements often involve significant modification of the original system, either by the original developer or by the foreign marketer of the system, and tend to be carried out through licensed coproduction. They are often industry-initiated.

Teams are created when companies agree to work together to pursue a particular project or an entire market segment. An important char-
Table 2.2
Common Types of Cross-Border Business Relationships Within the Defense Aerospace Industry

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime/subcontractor</td>
<td>One company (the prime) hires another company (the subcontractor) to perform a specific task. The subcontractor is legally required to meet objectives specified under the terms of the contract. May be government- or industry-initiated.</td>
</tr>
<tr>
<td>Marketing agreement</td>
<td>Two or more companies agree to distribute an existing product, i.e., one that has already been developed by one of the partners. Marketing agreements may include modification of the item and licensed coproduction of the item by the nondeveloping partner. Industry-initiated.</td>
</tr>
<tr>
<td>Team</td>
<td>Two or more companies agree to work together as approximately equal partners to pursue a specific project or a larger market segment. Our focus is on teams formed to cooperatively develop and/or manufacture products under collaborative production or FMS coproduction arrangements. May be government- or industry-initiated.</td>
</tr>
<tr>
<td>Joint venture</td>
<td>Two or more companies form a separate legal entity in order to pursue a particular program or a larger market segment. Our focus is on joint ventures formed to cooperatively develop and/or manufacture products. Industry-initiated.</td>
</tr>
<tr>
<td>Parent/subsidiary</td>
<td>One company (the subsidiary) is wholly owned or effectively controlled by another company (the parent) physically located in another country. A subsidiary may be formed either as a new establishment or as a result of a purchase of an existing establishment. Our focus is on the foreign acquisition of established U.S. defense firms or divisions of firms and vice versa. Industry-initiated.</td>
</tr>
</tbody>
</table>
acteristic of teams—as opposed to, say, parent/subsidiary relationships—is that international teams are not formally subject to CFIUS review (see Chapter Four). Teams formed to target entire market segments are sometimes called “strategic alliances.” Decision-making authority within teams is shared; who decides what and how depends on rules established by the team members or, if the team was initiated by governments, sometimes by the participating governments. We are most interested in teams that are formed for purposes of codevelopment and partnership coproduction or for FMS coproduction.

Finally, international subsidiaries and joint ventures are each created when a parent company in one country either acquires an existing foreign firm or establishes a new affiliate in a foreign country—or, in other words, engages in direct investment abroad. For many but not all legal purposes, both subsidiaries and joint ventures are independent entities from the parent companies that control them. In the past, international joint ventures were generally formed in order to target specific weapon system programs; more recently they also appear to serve as “test runs” for the potential merger of their parent companies. Foreign subsidiaries are established or acquired for a number of reasons, including access to foreign technology, access to a foreign market, and economies of scope and scale. Although joint ventures and parent/subsidiary relationships are both industry-initiated, a key difference between them is the nature of management control. While subsidiaries are controlled by a single parent, joint ventures must answer to two. Because corporate parents can have conflicting—or just different—goals and priorities, joint ventures frequently do not have a long life-span.

---

It is sometimes difficult to distinguish between teams and more formal prime/subcontractor relationships. On the JSF program, for example, Northrop Grumman and BAE Systems are formally subcontractors but are often described as part of a Lockheed-led team.
U.S. TRADE IN AEROSPACE AND ARMS: STATISTICAL EVIDENCE

Trade in Aerospace Products: A Statistical Snapshot

In absolute terms, according to AIA (2000), U.S. exports of aerospace products in 1999 totaled just over $62 billion, while imports stood at less than half that amount, at $25 billion. The export orientation of U.S. aerospace producers is evident when exports and imports are measured in relation to total U.S. production and apparent consumption of aerospace products: Between 1997 and 1999, U.S. aerospace exports on average accounted for roughly 44 percent of total U.S. aerospace product shipments, while U.S. aerospace imports accounted for roughly 22 percent of all U.S. aerospace consumption (ITA, 2000).\(^{24}\) As shown in Figure 2.1, compared with several other high-technology and manufacturing industries over the same period, the difference between import and export shares places the aerospace industry squarely at the export-dependent end of the spectrum.

More detailed data, however, reveal some divergence within the industry. ITA (2000) divides the U.S. aerospace industry into six segments:

- Complete aircraft, accounting for about 47 percent of all U.S. aerospace shipments by value in 1999;
- Aircraft engines and their parts, accounting for about 18 percent of shipments;
- Aircraft parts and equipment, accounting for about 20 percent of shipments;
- Guided missiles and finished space vehicles, accounting for about 11 percent of shipments;
- Space propulsion units and parts, accounting for about 3 percent of shipments; and

---

\(^{24}\) Following the ITA, export dependence ratios are calculated by dividing exports by total shipments (production), while import penetration ratios are derived by dividing imports by “apparent consumption”—that is, by the sum of total shipments and total imports less total exports.
Figure 2.1—Trade Shares of U.S. Consumption and Shipments for Selected Manufacturing Industries (1997–1999 averages)

- Space vehicle equipment, accounting for about 2 percent of shipments.

As shown in Figure 2.2, between 1997 and 1999 the average difference between export and import shares was widest for complete aircraft, where the export share of product shipments was about 54 percent and the import share of consumption about 18 percent. The export and import shares for aircraft parts and equipment, space vehicle equipment, and guided missiles and space vehicles also diverged significantly, with the export shares all much higher. The ex-
Figure 2.2—Trade Shares of U.S. Consumption and Shipments for Six Aerospace Industry Subcategories (1997–1999 averages)

Unfortunately, ITA does not distinguish between military and nonmilitary categories of products for the six aerospace industry segments described above. However, by combining ITA and AIA data we can compare the export and import shares for complete military and civil aircraft (Figure 2.3). The differences between export and import shares—and between military and civil aircraft trade—are striking. For military aircraft, the average export share of shipments from 1997 to 1999 was about 24 percent. The import

---

25Note that there is very little trade in space propulsion units and parts.
26As a result of differences in coverage, these numbers are not strictly comparable to those presented above.
share of consumption over the same period was less than 1 percent—invisible in the figure. For civil aircraft, the export share of shipments over the period was about 71 percent, while the import share of consumption was about 37 percent.

These numbers support two conclusions: first, that the United States imports almost no finished military aircraft; and second, that exports play a smaller role for producers of military aircraft than they do for producers of nonmilitary aircraft.

Finally, ITA provides some country-specific data on U.S. aerospace trade. These data are limited, however, because they are available only for the industry in aggregate; no breakdowns by military or nonmilitary end use or by manufacturing stage are available. As

\[\text{SOURCE: ITA (2000); AIA (2000)}.\]

Figure 2.3—Trade Shares of U.S. Military and Civil Aircraft Consumption and Shipments (1997–1999 averages)
shown in Table 2.3, the top export market for U.S. aerospace products in 1998 was the United Kingdom, followed by Japan, Saudi Arabia, France, and Germany. With respect to imports, the top supplier to the U.S. market in 1998 was France; the UK, Canada, Japan, and Germany round out the top five.28

**Trade in Conventional Arms: A Statistical Snapshot**

The three primary sources of data on the global arms market (that is, conventional arms production and transfers) all agree that the United States is the world’s leading exporter and producer of conventional arms (Table 2.4). Between 1995 and 1999, U.S. producers accounted for roughly half of all world exports and about the same share of world production. The top four exporting countries—the United States, the UK, France, and Russia—accounted for between 75 and 85 percent of the global market, depending on the data source and time period chosen. Delivery data for 1997–1999 from IISS, for example, identify the world’s top three exporters as the United States, UK, and France, together accounting for about 80 percent of all conventional arms exports over that period (IISS, 2000). The top exporters were also the top producers overall: SIPRI finds, for example, that the world’s three largest arms-producing countries in

<table>
<thead>
<tr>
<th>Exports</th>
<th>Value ($M)</th>
<th>Share (%)</th>
<th>Imports</th>
<th>Value ($M)</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United Kingdom</td>
<td>7248</td>
<td>12</td>
<td>France</td>
<td>5539</td>
<td>25</td>
</tr>
<tr>
<td>Japan</td>
<td>5922</td>
<td>10</td>
<td>United Kingdom</td>
<td>4635</td>
<td>21</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>4946</td>
<td>8</td>
<td>Canada</td>
<td>4445</td>
<td>20</td>
</tr>
<tr>
<td>France</td>
<td>4100</td>
<td>7</td>
<td>Japan</td>
<td>1878</td>
<td>8</td>
</tr>
<tr>
<td>Germany</td>
<td>4048</td>
<td>7</td>
<td>Germany</td>
<td>1841</td>
<td>8</td>
</tr>
<tr>
<td>Top five</td>
<td>26,264</td>
<td>44</td>
<td>Top five</td>
<td>18,338</td>
<td>82</td>
</tr>
</tbody>
</table>


---

28France’s position as the top exporter of aerospace products to the United States is probably due to shipments of commercial transports. Airbus Industries’ primary assembly plant is located in Toulouse.
Table 2.4
Leading Exporters of Conventional Arms According to Three Data Sources
(percentage of world exports)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>55</td>
<td>49</td>
<td>48</td>
<td>45</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>13</td>
<td>19</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>8</td>
<td>11</td>
<td>14</td>
<td>9</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>15</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>United States, UK, France</td>
<td>76</td>
<td>79</td>
<td>80</td>
<td>62</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>United States, France, Russia</td>
<td>70</td>
<td>66</td>
<td>67</td>
<td>69</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Top four</td>
<td>83</td>
<td>85</td>
<td>85</td>
<td>77</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Percentages are based on period average export values.

1996, excluding China, were the United States, the UK, and France (SIPRI, 2000). These three countries together accounted for slightly more than 65 percent of global production, while the United States, Russia, and France accounted for about 60 percent.29

As shown in Table 2.5, arms exports are highly concentrated geographically in comparison to other manufacturing exports, such as office and telecommunications equipment and automotive products. According to the World Trade Organization (WTO) (2000), the cumulative concentration ratio in 1999 for the top three countries exporting automotive products was about 44 percent. This was less than the United States’ individual share of global arms exports at any time between 1995 and 1999, whether estimated by DoS, IISS, or SIPRI.

At the same time, Table 2.5 indicates that the geographic concentration of conventional arms imports is considerably lower than that for exports and also lower than that for other manufactured products. For example, SIPRI’s top three arms importers—based on period average data for 1995–1999—were Taiwan, South Korea, and Saudi Arabia. Together, these three countries accounted for 20 percent of

---

29Calculations are based on SIPRI (2000, Table 10.7).
Table 2.5
Leading Exporters and Importers of Selected Manufactures, 1999

<table>
<thead>
<tr>
<th></th>
<th>All Manufactures</th>
<th>Office Machines and Telecommunications Equipment</th>
<th>Automotive Products</th>
<th>Conventional Arms(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Percentage of World Exports</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td>14</td>
<td>United States</td>
<td>16</td>
<td>Germany 17</td>
</tr>
<tr>
<td>Germany</td>
<td>11</td>
<td>Japan</td>
<td>12</td>
<td>Japan 15 Russia 15</td>
</tr>
<tr>
<td>Japan</td>
<td>9</td>
<td>Singapore(^b)</td>
<td>8</td>
<td>United States 12 France 8</td>
</tr>
<tr>
<td>Top three</td>
<td>34</td>
<td>Top three</td>
<td>36</td>
<td>Top three 44 Top three 74</td>
</tr>
</tbody>
</table>

|                      |                  |                                                 |                      |                          |
| **Percentage of World Imports** |                  |                                                 |                      |                          |
| United States        | 19               | United States                                  | 22                   | Taiwan 28               |
| Germany              | 8                | UK                                              | 7                    | Germany 8 South Korea 6  |
| UK                   | 6                | Germany                                         | 6                    | Canada 8 Saudi Arabia 6  |
| Top three            | 33               | Top three                                       | 35                   | Top three 44 Top three 20 |

**Sources:** WTO (2000), Tables IV.30, IV.56, and IV.64; SIPRI (2000), Table 7A.1

\(^a\)Period average data for 1995–1999.

\(^b\)Data for Singapore include reexports.

total world imports of major conventional weapons, compared to 1999 percentages of 33, 35, and 44 percent, respectively, for the top three importers of all manufactures, office machines and telecommunications equipment, and automotive products.\(^{30}\) Using the broader DoS definition of the arms trade results in a slightly different top three consisting of Taiwan, Japan, and Saudi Arabia—which together accounted for about 36 percent of average global receipts from 1995 to 1997. This estimate of the arms import concentration ratio is more in line with import ratios for other manufacturing in-

\(^{30}\)These figures must be interpreted with care. For example, Canada’s large import share of the world automotive market primarily represents imports of automotive production inputs rather than consumer purchases of finished automobiles.
dustries but is still significantly lower than any of the estimated geographic concentration ratios for arms exports.

For the United States, the combined share for the top three export destinations identified by SIPRI—which also happen to be Taiwan, South Korea, and Saudi Arabia—averaged roughly 38 percent between 1995 and 1999. If treated as a single entity, the European Union accounted for 22 percent of all U.S. deliveries over this period—a surprisingly low figure given America’s historical focus on promoting transatlantic NATO equipment standardization and interoperability through collaborative programs and exports. The broader DoS estimates place Saudi Arabia, Taiwan, and Japan as the top three destinations for U.S. arms exports from 1995 to 1997. According to DoS, these three countries accounted for approximately 37 percent of U.S. deliveries to foreign countries (DoS, April 2000).

In contrast to its critical role as a major exporter of conventional arms, the United States plays a relatively modest role as an importer. From 1995 to 1997, the United States accounted for no more than 3 percent of the world’s imports on average (DoS, Bureau of Verification and Compliance, 2000). Yet over the same period, the United States accounted for about 34 percent of the world’s total defense expenditures. Unfortunately, the U.S. share of global weapon procurement—a more accurate measure of the demand for conventional arms—is unclear because reliable worldwide data on weapon procurement are unavailable.31 Between 1997 and 1999, however, the U.S. share of NATO’s total defense expenditures and its share of budgeted equipment procurement were both roughly equal to 60 percent, while the United States accounted for no more than about 14 percent of NATO’s total arms imports (IISS, 2000); NATO, 2000b; DoS, April 2000).32

Those weapon systems that are bought by the United States appear to come mostly from European NATO allies and non-NATO Western Europe. SIPRI does not provide geographic breakdowns for U.S. receipts of arms from abroad, but according to DoS, European NATO

---

31Data on defense expenditures are an inexact proxy for procurements because they cover a broad range of nonprocurement activities.

32SIPRI (2000) puts the U.S. share of NATO imports at about 12 percent for the period 1995–1997 but drops it to 7.3 percent on average from 1997 to 1999.
allies plus non-NATO Western Europe accounted for roughly three-quarters of all U.S. imports from 1997 to 1999. The UK alone accounted for almost 30 percent of total U.S. arms receipts. Exports to the United States amounted to about 7 percent of European and NATO countries' total arms exports over the 1997–1999 period; in the case of the UK, the United States accounted for 10 percent of total transfers. Nevertheless, one European government agency estimates that between 1995 and 1999, the value of U.S. defense exports to Europe was more than eight times greater than the value of European exports to the United States.33

INTERNATIONAL INVESTMENT INVOLVING U.S. FIRMS: STATISTICAL EVIDENCE

Broad Trends in International Investment Activity

A number of data sources help place cross-border investment involving aerospace firms in the broader context of the global economy and defense-related industries. According to BEA (July 2001), in 1999 the U.S. affiliates of foreign companies accounted for a record 6.4 percent of total private-industry gross domestic product (GDP), continuing a four-year upward trend.34 Direct investment inflows—which include equity, debt, and reinvested earnings flows to existing affiliates as well as investments in new acquisitions—were strong, increasing by 25 percent between 1999 and 2000.35 Foreign companies and their U.S. affiliates increased their outlays for new and existing U.S. businesses by 17 percent over the same period. This unprecedented level of foreign spending to establish or acquire U.S. businesses is consistent with a worldwide increase in M&A activity in which U.S. firms were both the leading purchasers and the leading sellers (BEA, June 2001; KPMG, 2001).36

33This estimate was provided to the authors from a British Ministry of Defence official.
34See BEA (August 2001, p. 141) for details on the calculation methodology for private-industry GDP.
35Estimated on a current cost basis. See BEA (July 2001, p. 7) for definitions.
36A KPMG finance survey suggests that for the decade of the 1990s, the United States accounted for about 22 percent of the value of all cross-border purchases of companies and 30 percent of the value of all cross-border sales (KPMG, 2001).
By country of ultimate beneficial owner, BEA (June 2001) reports that European investors accounted for 75 percent of total outlays to acquire or establish U.S. businesses in 1998–2000. British investors led the pack, spending more than three times as much as investors from the country with the next-largest outlays, the Netherlands. In fact, British investors accounted for fully one-third of new direct investment outlays over the period.

Strong financial ties between the United States and the UK are also evidenced in the data on U.S. direct investment abroad, where the UK is the destination of choice for many U.S. firms seeking foreign affiliates. The UK was a focal point for new U.S. investment in 1998, accounting for about 18 percent of the number, 35 percent of the asset value, and 32 percent of the sales of all newly acquired or established majority-owned foreign affiliates in 1998. According to BEA (2000b, pp. 33–34), the UK is favored by U.S. investors “because of its language and its cultural similarities with the United States, its relatively low level of market regulation . . . and its duty-free access to customers in other member countries of the European Union.” Overall, total U.S. net financial outflows to all foreign affiliates were at a near record in 2000, reflecting numerous large acquisitions abroad. Net equity capital outflows (as opposed to intercompany debt or reinvested earnings) represented roughly one-third of the total (BEA, July 2001).

Mergerstat data point to an economy-wide increase in the M&A activities of all U.S. firms in terms of both numbers and value while also providing some information on the activities of aerospace firms. Figure 2.4 shows the rise in U.S. overall domestic and cross-border M&A activity over the past decade. According to Mergerstat, the U.S. aerospace industry accounted for less than one-quarter of a percent of the value of all U.S. domestic and cross-border M&As during the

---

37 According to BEA (June 2001, p. 28), the “ultimate beneficial owner is that person, proceeding up a U.S. affiliate’s ownership chain, that is not owned more than 50 percent by another person.”
1990s, placing it 37th among all U.S. industries. This is somewhat less than aerospace’s share of domestic economic activity, which in recent years has accounted for approximately 0.7 to 0.9 percent of U.S. GDP.

Mergerstat data also indicate that the aerospace industry was somewhat less active in domestic and cross-border M&As relative to other

---

38 The aerospace data also cover firms whose primary products are combat vehicles. In 2000, the top three industries for M&As by value were computer software and services, entertainment and leisure, and banking and finance. Mergerstat tracks almost all M&A transactions that occur; however, some transactions between privately held companies may be missed.

U.S. manufacturing industries. As shown in Figure 2.5, aerospace ranked second to last in terms of both the average number and the average total value of manufacturing M&As between 1995 and 1999. At the top of the list were electrical equipment manufacturers, followed by car companies and measuring instruments and photographic equipment manufacturers.40

40Unfortunately, we were not able to find data on the relative number of firms or total value of these industries. We believe it is telling, however, that the number of M&As in the category “Industrial and Farm Equipment,” for example, was much higher than that for “Aerospace and Defense.”
International Investment in Defense-Related Industries

In a recent DoD study, Ciardello (2001) provides information on a subset of defense-related, though not necessarily aerospace-related, foreign direct investment in the United States. The Ciardello data distinguish between total and specifically “defense-related” cases from 1996 to 2000. Of 322 CFIUS cases filed and reviewed by DoD over the past five years, the data identify 235, or nearly three-quarters, as defense-related. As shown in Figure 2.6, the number of cases reviewed has increased—though not dramatically—in recent years. This probably points to an increase in the total number of defense-related foreign acquisitions.

Figure 2.7 shows the distribution of defense-related CFIUS cases from 1996 through 2000 for the top three countries of origin. Over this five-year period, the UK, France, and the Netherlands accounted for almost two-thirds of the cases. At about 46 percent of the total, the UK accounted for the largest number of cases, followed by France at roughly 12 percent and the Netherlands at approximately 6 percent.

Ciardello (2001) also presents data on measures designed to eliminate possible security violations resulting from transactions that put U.S. firms under foreign ownership, control, or influence (FOCI). These measures, which are described in more detail in Chapter Four, mitigate foreign influence and control for companies performing U.S. classified work. As shown in Figure 2.8, the UK accounts for the largest single country share of FOCI mitigation measures, about 48 percent. This is consistent with the UK’s dominant share of defense-related CFIUS activity as well as with its role as the single largest foreign direct investor in the U.S. economy.

Finally, the DBP’s Globalization Database, described in Bitzinger (1999), distinguishes between licensed production—which is assumed to involve minimal collaboration—and more collaborative
Figure 2.6—Total and Defense-Related CFIUS Reviews, 1996–2000

Figure 2.7—Shares of Defense-Related CFIUS Transactions for Top Three Countries, 1996–2000
activities such as marketing agreements, coproduction, and codevelopment.41 Within the last category, the data further distinguish between relationships initiated by governments (where company work shares are often allocated according to governmental shares of the program budget) and those initiated by industry (where cost minimization strategies are presumably more likely to be followed). Programs covered include RDT&E and production programs for large weapon systems such as aircraft, missiles, and armored vehicles, as

41Coproduction activities are defined as the “joint production of a common weapon system” (Bitzinger, 1999, p. 311). The DBP data do not distinguish between FMS coproduction and partnership coproduction programs, but both are assumed to require more complex cross-border business relationships than simple licensed production activities.
well as for major components such as radar systems and jet engines (Bitzinger, 1999, p. 331).

Figure 2.9, which uses DBP data, shows the declining numbers of traditional licensed-production arrangements relative to U.S. participation in international aircraft and missile codevelopment and coproduction programs (as defined by Bitzinger). To convey a better sense of long-term trends, program startups are organized into five-year cohorts. We see that prior to about 1981, licensed production was the dominant form of international collaboration in armament ICRD&A programs. Beginning in the early 1980s, however, licensed production began to decline in importance relative to codevelopment, partnership coproduction, and FMS coproduction. By 1991–1995, licensed production program startups constituted less than half the total.

Figure 2.9—Cross-Border Collaborative Activities of U.S. Firms in Military Aircraft and Missiles

42 These figures represent startups only; some programs may not have been completed.
The DBP data also provide an important insight into the increasingly market-driven character of the relationships being formed by U.S. aerospace and other defense firms. As shown in Figure 2.10, the number of program starts involving industry-initiated collaboration among U.S. and foreign firms to market, produce, and/or develop aircraft and missile systems rose from fewer than five during the 1971–1975 period to more than 30 from 1991 to 1995. This suggests that aerospace companies, rather than national governments, are increasingly responsible for determining the nature of their own cross-border business relationships. Bitzinger (1999, p. 316), describes the trend in this way: “As a result of defense firms themselves taking the lead, international arms production increasingly has involved ever more complex, integrated, and permanent cross-border industrial partnerships.”
SUMMARY OF STATISTICAL EVIDENCE

Although there is relatively little statistical data specific to defense aerospace systems and subsystems, aggregate data on the production, consumption, and trade of aerospace products—as well as on the production and international transfers of conventional armaments—reveal certain patterns that help inform our analysis of defense aerospace industry globalization. For aerospace products, our major findings are as follows:

- The U.S. aerospace industry has a strong export orientation relative to other U.S. manufacturing industries.
- Nonmilitary producers are more internationally active than are military producers.
- With the exception of aircraft engines and space propulsion units, levels of import penetration in the U.S. aerospace industry are low.
- The United States imports almost no finished military aircraft.
- In 1998, the top two destinations for U.S. combined civil and military aerospace products were the UK and Japan; the leading suppliers to U.S. industry were France and the UK.

For conventional armaments, we found the following:

- The United States leads the world in both the export and the production of conventional arms.
- Exports and production of conventional arms are highly concentrated geographically relative to other manufacturing industries.
- Global imports are fairly diffuse geographically.
- The United States leads the world in defense expenditures but receives relatively few conventional arms transfers from abroad.
- U.S. purchases of foreign armaments come overwhelmingly from Europe, primarily from the UK.

With respect to financial flows, aggregate data on foreign direct investment in the United States as well as U.S. direct investment abroad indicate the following:
U.S. firms are both the leading purchasers of foreign firms and the leading targets of foreign acquirers.

Europeans, led by the British, are the most active foreign investors in U.S. businesses, while the UK is the most popular destination for new U.S. investment abroad.

The number and value of U.S. domestic and cross-border mergers rose dramatically during the 1990s.

Data on selected foreign direct investments in U.S. defense companies and on international collaborative activities suggest that

- There has been a slight increase in CFIUS reviews of foreign defense acquisitions in recent years.
- Two-thirds of the cases reviewed by CFIUS involved British, French, or Dutch firms, with British firms alone accounting for almost half the cases.
- Traditional licensed production arrangements are declining in importance relative to U.S. participation in codevelopment and coproduction programs (as defined by Bitzinger, 1999).
- Aerospace companies, rather than national governments, are increasingly responsible for determining the nature of their own cross-border relationships.

Our analysis of the statistical data confirms two frequently stated observations about the U.S. defense aerospace industry: Its products are highly competitive on world markets, and it is not very reliant on foreign suppliers. Although the data on cross-border investment in defense cannot automatically be extrapolated to aerospace firms, they are also consistent with the observation that U.S. defense firms are partnering with foreign firms in a variety of ways for a variety of activities. British firms are frequently their partners of choice.

What these statistical snapshots cannot tell us is how patterns of trade and investment in defense aerospace have changed over time; how they have been affected by changes in the U.S. regulatory environment or in DoD policy; or what sorts of opportunities and challenges these changes pose to the Air Force. For example, the statistical data do not reveal to what extent offset agreements—such as
counterpurchases of goods, technology transfers, credit transfers, and various forms of investment—have been imposed on would-be exporters. Nor do they record the capabilities or degree of sophistication of defense aerospace exports and imports. With the exception of Bitzinger (1999), the data do not provide any information about the companies that develop and produce air-based weapon systems—for example, who their suppliers and partners are or to what extent they rely on foreign inputs, foreign technology, or foreign markets. Finally, the data do not provide sufficient information to assess whether and how much current patterns might change in the absence of existing U.S. government legislation, regulations, and statutes.

In the section that follows, we present a brief historical overview of some of the major trends in U.S. defense aerospace system trade and cross-border business relationships. With this short descriptive survey, we hope to deepen our understanding of the changes that are taking place both in the United States and overseas, thereby helping identify key issues the Air Force must address with respect to shaping and managing those changes.

DEFENSE AEROSPACE GLOBALIZATION: HISTORICAL TRENDS

Trends in U.S. Defense Aerospace Exports

As revealed by the statistical snapshot above, the United States is the world’s undisputed leader in arms exports, laying claim to more than half of the global market. Yet the characteristics and requirements of the arms export market have changed significantly over the decades since the end of World War II. These changes in arms export markets have greatly contributed to the evolution of the more complex business relationships we observe today.

For approximately the first two decades following World War II, U.S. contractors typically exported finished defense goods—including complete military aircraft—even to industrially sophisticated Western European markets. In the 1950s, for example, the Republic F-84 and the North American F-86 were widely exported as complete
aircraft to countries with historically robust military aircraft industries, such as France.43

By the late 1960s, however, many European countries as well as Japan increasingly insisted on coproducing U.S.-designed military aircraft under license rather than importing finished products. One of the most important early programs involved the coproduction of the Lockheed F-104G (a specially modified variant of the F-104A) by a consortium of European countries that included Germany, Italy, Belgium, and the Netherlands.44 Initially, Lockheed provided complete aircraft. Next, knockdown kits of parts of aircraft for FACO overseas were provided along with extensive technical manufacturing process and engineering assistance. Over time, however, the European partners began to build more and more of the F-104G and its subcomponents indigenously while simultaneously undertaking FACO. Some European coproducers, such as the Germans, even began to modify and develop their own manufacturing processes for various parts of the U.S.-designed aircraft.45

By the 1970s, Western European countries with a long history of indigenous aircraft development were no longer interested in importing finished U.S. military aircraft or in coproducing them. Instead, France, Germany, the UK, and Italy moved toward the development and production of indigenous or collaboratively developed European combat aircraft, including the French Mirage III/5/2000 series, the British/French Jaguar, the British/German/Italian Tornado, and the French/German Alpha Jet.46 Although “second-tier” European NATO countries such as Belgium and the Netherlands continued to coproduce U.S. aircraft (e.g., the Northrop F-5 and the Lockheed/General Dynamics F-16), it had become clear that with the possible exception of highly specialized, low-production platforms, the leading European countries were unlikely ever again to buy or

---

43 Many of these exports were elements of U.S. military assistance programs to European allies still recovering from the ravages of World War II.
44 The F-104 was also coproduced in Canada and Japan.
45 From an interview with a German government defense procurement official.
46 Sweden maintained its long tradition of developing its own indigenous fighter designs throughout the jet era but imported some U.S. components and subsystems.
coproduce a wholly U.S.-developed fighter or other first-line combat aircraft.47

In the 1960s and 1970s, U.S. companies did continue to export finished combat aircraft to developing countries such as Turkey; these deals often involved specially designed, lower-capability export combat aircraft such as the Northrop F-5. By the 1980s and 1990s, however, even developing countries began to demand and receive first-line U.S. combat aircraft. They also began insisting on offsets, including coproduction and technology transfer. With European manufacturers competing with increasing vigor for every third-country sale of combat aircraft, competitive pressure on U.S. manufacturers grew more intense. In order to sell its F-16 to Turkey in the 1980s, for example, General Dynamics (now Lockheed Martin) agreed to coproduce and to establish a manufacturing facility outside Ankara that duplicated on a smaller scale its vast production facilities in Fort Worth, Texas. General Dynamics also agreed to seek out and train Turkish firms to manufacture even some of the most sophisticated components of the fire control radar and other electronics.48

Table 2.6 shows some typical examples of the more complex business activities involved in recent export sales. The Greek Air Force’s third purchase lot of F-16s, concluded in the spring of 1999, includes offsets in the form of related subcontracts and involves an upgraded long-range variant with conformal fuel tanks (F-16 Block 50+) that is not in the U.S. Air Force inventory. The sale was a commercial deal rather than part of a government-sponsored FMS program. The Israeli Air Force, which already operates the largest fleet of F-16s outside the U.S. Air Force, decided to purchase more of a specially modified Block 50+ variant in July 1999. The Israeli variant incorporates major airframe modifications not seen on U.S. Air Force F-16s, including conformal fuel tanks and, on some two-seat models, a

47 European purchases of specialized U.S.-developed aircraft include the French Navy’s purchase of the Grumman E-2C airborne early warning (AEW) aircraft and both French and British purchases of the Boeing E-3 Airborne Warning and Control System (AWACS).

48 Turkey later gained the right to produce F-16s for a third-country sale to Egypt. As of this writing, 13 foreign countries are involved in offset agreements that include coproduction of the F-16 or supplier relationships on the program.
special humped dorsal spine stretching from the cockpit to the vertical stabilizer. This special spine is used for the installation of Israeli electronic warfare (EW) systems and other avionics. According to one report, an upgraded radar jointly developed by U.S. and Israeli industry will also be installed. Up to one-quarter of the manufacturing work will be conducted in Israel (Dworkin, 1999). These modifications are intended to transform the Israeli two-seat variant of the F-16 into a long-range interdictor, or a “poor man’s” F-15E. The aircraft will thus be used for different types of missions than are typical for standard U.S. Air Force F-16s. Lockheed subsequently sold the same dorsal hump airframe modification to Singapore, but with different avionics.

The United Arab Emirates (UAE) F-16 deal finally approved in the summer of 2000, which called for 60 dramatically upgraded Block 60+ fighters, is particularly revealing. The UAE F-16 will include mostly new avionics, the most important of which will be an active electronically scanned array (AESA) fire control radar developed by Northrop Grumman Electronic Systems. The new radar and avionics will make the UAE F-16 more capable in some respects than any F-16 in the U.S. Air Force inventory. This program is also of interest because its final approval was delayed more than one year as a result of a dispute over the transfer of sensitive software source code to the purchaser.

49Although the Israeli F-16I is a specially modified variant not used in the U.S. Air Force inventory, it is still considered an FMS coproduction arrangement because U.S. military assistance funds will be used to purchase the aircraft.
Finally, the competition for the Korean F-X future fighter, which was nearing its climax in late 2001, illustrates the intensity of competition between U.S. and European contractors for the few large fighter-aircraft export deals that remain. It also illustrates how these competitions lead to extraordinary offers of offsets and technology transfer to the buyer. The finalists in this competition in late 2001 were Boeing St. Louis with its F-15K; the British/German/Italian/Spanish Eurofighter consortium with its Typhoon; Dassault Aviation with its Rafale; and Russia’s Rosvorgeniea with its Sukhoi Su-37. A baseline requirement established by the Korean government was at least a 70 percent direct industrial offset arrangement. In addition, Korean President Kim Dae Jung stated in March 2001 that Korea intended to begin the development of a new-generation indigenous fighter by 2005, implying that the winner of the F-X competition should offer technology and design and engineering assistance in achieving this goal.

Not surprisingly, all four competitors claimed that their offset packages would exceed the 70 percent baseline, with each insisting that it would transfer the most technology and know-how if chosen. In addition, each argued that its proposal would do the most to support Korea’s efforts to develop a new-generation indigenous fighter by 2015. Dassault, for example, offered a direct partnership with Korean Aerospace Industries in manufacturing a significant percentage of the Rafale for the French armed forces and other foreign buyers as well as for the Korean Air Force. The French also argued that their technology transfer package was aimed specifically at aiding the development of a Korean indigenous fighter in 15 years. Boeing went one step further and “guaranteed the development of an indigenous fighter by 2015” if its F-15K was chosen (Kim, 2001).

The severe competitive pressures associated with programs such as the F-X—where foreign governments are able to demand generous direct offsets and significant technology transfer from firms and consortia that believe they must win to remain economically viable—has resulted in heavy lobbying by U.S. primes and industry associations to further liberalize U.S. export regulations and procedures. In the case of the Boeing F-15, which lost a hard-fought battle with the Lockheed F-16 for the Israeli fighter program in July 1999, a loss in the Korean program could mean the permanent shutdown of the F-15 production line, and with it the disappearance of a significant
percentage of the work performed at its St. Louis facilities.\textsuperscript{50} With so much at stake, it is not surprising that competing prime contractors are now routinely offering extremely generous offset and technology transfer incentives—and that U.S. firms bitterly complain about the export and technology transfer restrictions under which they must operate in this area compared to their European competitors.\textsuperscript{51}

**Trends in U.S. Defense Aerospace Imports**

Several points can be made with respect to the post–World War II history of U.S. imports of finished combat aircraft, which stands in stark contrast to U.S. export history:

- Imports are rare.
- They are usually UK-developed.
- They usually involve significant modification by U.S. contractors.
- They are largely coproduced in the United States.

With the possible exception of the British Aerospace (now BAE Systems) AV-8A Harrier, the United States has never deployed a first-line jet fighter/attack aircraft developed in a foreign country. In the early 1950s, the U.S. Air Force did procure a version of the English Electric Canberra twin-engine jet bomber. Called the B-57 in U.S. Air Force service, the Canberra was built under license by Martin Aircraft. However, most of the versions built in the United States were significantly modified to meet U.S. requirements.

The only combat aircraft in U.S. service to be built largely overseas was the AV-8A Harrier. As a result of U.S. Marine Corps requirements, however, this aircraft was also modified. The follow-on AV-8B Harrier II is a radically modified Harrier developed primarily by [50]The pressure on Boeing to win the F-X competition became even greater following the October 26, 2001, announcement that Lockheed Martin had been selected over Boeing to lead the development of the JSF.

[51]On the other hand, European producers claim that U.S. firms (in this case Boeing) have a significant advantage because of the close security relationship between the United States and Korea, as well as the fact that purchase of the F-15K would provide the Korean Air Force with greater standardization and interoperability with U.S. forces.
McDonnell Douglas (now Boeing) and coproduced with BAE Systems for both the UK and the United States. Indeed, the AV-8B Harrier II is virtually an all-new aircraft in design and materials. Similarly, the T-45 Goshawk, the U.S. Navy’s advanced jet trainer version of the BAE Hawk Royal Air Force trainer/light attack aircraft, includes numerous modifications to meet U.S. Navy requirements. Coproduced by BAE Systems and Boeing St. Louis (the prime contractor), it entered service in the early 1990s.

The Joint Primary Aircraft Training System (JPATS), which later became the Raytheon Beech T-6 Texan II, was intended to be a lightly modified off-the-shelf nondevelopmental item (NDI) from a foreign contractor teamed with a U.S. firm for coproduction in the United States. The goal was to reduce procurement costs and eliminate development costs. The Swiss Pilatus PC-9 won the original competition, but Navy and Air Force requirements as well as developmental problems evolved in such a way that they ultimately led to major modifications of the original aircraft.\textsuperscript{52} The resulting Raytheon Beech T-6A Texan II is practically an all-new aircraft that is manufactured at the Raytheon Beech Wichita plant. This program, too, would appear to illustrate that when the United States imports a foreign platform—which it rarely does—it often modifies that platform so significantly that anticipated benefits from the elimination of development costs are substantially reduced. Table 2.7 shows several examples of recent foreign-developed military aircraft and other aerospace system imports to the United States.

In areas other than complete combat aircraft, there have been several instances in which the United States has imported off-the-shelf foreign items. Often, U.S. firms have later developed long-term strategic relationships with the foreign partner to upgrade and further market such items. Prime examples include the original Popeye/HAVE NAP air-to-ground missile developed by the Israeli

\textsuperscript{52} Each of the seven competing foreign developers was teamed with a U.S. contractor; for example, Pilatus was teamed with Beech/Raytheon.
Table 2.7
Examples of Recent U.S. Military Aerospace System Imports

<table>
<thead>
<tr>
<th>U.S. System and Contractor</th>
<th>Country of Origin</th>
<th>Original System and Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV-8A Harrier</td>
<td>UK</td>
<td>Modified BAE Harrier combat aircraft</td>
</tr>
<tr>
<td>AV-8B Harrier, coproduced by Boeing (formerly McDonnell Douglas)</td>
<td>UK</td>
<td>Radically modified BAE Harrier combat aircraft</td>
</tr>
<tr>
<td>T-45 Goshawk, coproduced by Boeing</td>
<td>UK</td>
<td>Modified BAE Hawk trainer/light attack aircraft</td>
</tr>
<tr>
<td>T-6A Texan II (JPATS), produced by Raytheon Beech</td>
<td>Switzerland</td>
<td>Greatly modified Pilatus PC-9 combat trainer</td>
</tr>
<tr>
<td>Popeye/HAVE NAP&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Israel</td>
<td>Air-to-ground missile developed by the Rafael Armament Authority</td>
</tr>
<tr>
<td>Pioneer unpiloted aerial vehicle (UAV)</td>
<td>Israel</td>
<td>Surveillance aircraft developed by Israel Aircraft Industries (IAI)</td>
</tr>
</tbody>
</table>

<sup>a</sup>See Chapter Five for more on the Popeye.

Rafael Armament Authority and the Pioneer unpiloted aerial vehicle (UAV) developed by Israel Aircraft Industries (IAI). In both cases, the foreign firm eventually formed joint ventures with U.S. companies to facilitate the marketing and support of the item for the U.S. government. In 1991, IAI joined with the U.S. AAI Corporation, located in Hunt Valley, Maryland, to form a jointly owned corporation called Pioneer UAV, Inc., to act as the prime contractor to the U.S. government. The Pioneer was procured by the U.S. Navy, Marines, and Army and was extensively employed in the Gulf War. AAI later developed at least two improved upgraded variants of the Pioneer, the Shadow 200 and the Shadow 600. It is unclear from published sources whether or not these improved versions were developed in collaboration with IAI.

The U.S. Air Force originally bought the Popeye, an air-to-ground standoff missile, directly off the shelf from Rafael. However, Rafael later formed a joint venture with Lockheed to continue upgrading and marketing the Popeye. These changed business arrangements for the same foreign system are discussed in greater detail in Chapter Five.
CONCLUSION

In conclusion, aerospace exporting on the weapon system platform level, which once involved the relatively straightforward sale and transfer of finished goods from the supplier/developer to the purchaser, has evolved to encompass a wide variety of complex business arrangements involving a range of activities, including countertrade, offsets, coproduction, foreign investment, marketing agreements, major cooperative R&D and modification efforts, and significant technology transfer issues. Major trends in U.S. combat aircraft exports since the 1950s include the following:

- A move away from lower-capability export aircraft and other systems to high-end aircraft and systems closer in capabilities to those in the U.S. inventory;
- The growing importance of industrial and technological offsets;
- An increasing trend toward FMS and licensed coproduction of the purchased item in the purchasing country;
- The increasing importance of direct commercial sales compared to U.S. government–administered FMS;
- The emergence of significantly modified variants developed by U.S. contractors, sometimes in collaboration with foreign contractors, solely for the use of foreign customers; and
- Growing involvement of the purchaser in R&D, combined with increased demand for access to U.S. technology.

Nevertheless, U.S. primes often believe they are at a disadvantage when competing with European contractors because of the perception of more restrictive and bureaucratic procedures imposed by the U.S. government for export control, technology transfer, and offsets.

On the import side, the U.S. government appears to have benefited from the rare cases in which it has imported major systems. In the case of the original Harrier, the United States benefited by buying off the shelf a unique technology developed overseas. Building on that technology, the United States subsequently developed much more capable variants. In both cases, standardization and interoperability were enhanced with a key ally, the UK. In the case of the Popeye and the Pioneer UAV, the U.S. armed forces were able to gain quick ac-
cess to existing systems that had no exact equivalent in the United States. Later, U.S. industry was also able to build on and improve the technology from these imported systems.

The export and import of finished aerospace goods now involves all categories of cross-border business relationships and activities that we have identified in our typologies. The substantive program differences between the export of systems and subsystems on the one hand and cooperative development and cross-border investment on the other have continued to diminish. As a result, the regulatory regime and issues of technology security have become much more prominent and complex, as demonstrated by the UAE F-16 sale and the Korean F-X program.

However, unique concerns about national security have given rise to a host of policy instruments that may be affecting the development of the aerospace market and may possibly explain some of the patterns that we observe in the data. Some of these instruments seek to promote cross-border activities, while others—such as the International Traffic in Arms Regulations (ITAR), which set controls for U.S. exports of weapons and technology, the Buy American Act, which places limits on U.S. government purchases of foreign supplies; and the CFIUS process, which oversees foreign capital inflows—seek to restrict them. Whether these restrictive instruments create unnecessary or undesirable barriers to trade, investment, and other business relationships has been the subject of an ongoing debate that is discussed in Chapter Three. At the same time, other international programs, such as FMS and Foreign Military Financing (FMF), may serve to subsidize and encourage U.S. weapon exports.

Because the intent of these policy instruments is to protect national security, the central question for policymakers is not whether they affect cross-border trade, investment, and other business activities—they are intended to do so—but whether they affect such activities unnecessarily or undesirably. U.S. policy instruments, including those that seek to promote international transactions, may affect both the extent of cross-border activity and its character. Firms may be opting for or against particular forms of cross-border collaboration in response to the policy environment. In addition, other, more subtle market conditions, such as purchasers’ attitudes, may affect firms’ behavior as well. If purchasers in the United States and over-
seas are more comfortable buying domestically, it may be difficult for U.S. firms to enter foreign markets and for foreign firms to enter U.S. markets.

A key step in developing an Air Force strategy for managing globalization is to better understand why, in practice, certain types of activities seem to be associated with certain types of business relationships. It is of particular interest to clarify whether these relationships and activities generally support the three overarching Air Force objectives identified in Chapter One: enhanced market sector competition (with its attendant benefits, price reduction, and technical innovation), standardization or interoperability with key allies, and preservation of national security. This question is the focus of the chapter that follows.