Industrial Policy and Trade Management in the Commercial Aircraft Industry.*

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I. Historical Decisions in a Strategic Industry

"Judged against almost any criterion of performance--growth in output, exports, productivity, or innovation--the civilian aircraft industry must be considered a star performer in the [postwar] U.S. economy."[1] The industry stands out as the country's largest exporter, running a net surplus of $35 billion between 1985 and 1989. American producers account for almost 80% of the world's commercial aircraft fleet (excluding the former USSR). More than any other, the commercial aircraft industry is a symbol of America's technological and market dominance. But today American producers face two critical challenges: an internal challenge resulting from cutbacks in defense procurement and indirect military subsidies; and an external challenge resulting from the growing competitive strength of Airbus. Continued American success depends on how American companies and the American government respond to these two challenges.

Airbus is a government-backed consortium of companies from France, Britain, Germany, and Spain.[2] After two decades of massive government support, Airbus has developed a family of aircraft, capturing about one-third of the world market for large commercial jets in 1991, up sharply from its 14% share in 1981. It has achieved technological parity with Boeing and replaced McDonnell-Douglas as the second largest producer in the world. Since 1990, the Europeans have been debating when to subsidize and launch the A-350, a 600-seat jumbo airplane about one-and-one-half times larger than the Boeing 747. A successful launch of the A-350 would pose a major competitive threat to Boeing, the leading American producer, which has claimed about 51% of the global market during the last five years.[3]

Meanwhile, McDonnell-Douglas (MD), the nation's second largest commercial producer and its largest military contractor, is facing possible bankruptcy in its commercial operations and dramatic cutbacks in its already strapped military operations. Its most recent commercial model, the MD-11, has not delivered either its promised flight range or the revenues required for developing a complete family of aircraft for future rounds of competition. Substantial reductions in military

[1] David Mowery and Nathan Rosenberg, "The Commercial Aircraft Industry," in Richard Nelson ed. Government and Technical Progress (New York: Pergamon Press, 1982), pp. 101-2.

[2] The companies from the four nations are France's Aerospatiale, Germany's Deutsche Airbus, Britain's British Aerospace, and Spain's CASA.

procurement, with more to come, threaten MD's military operations as well. Even under the most optimistic scenarios, further contractions in these operations seem inevitable. At the end of 1991, MD sought relief from the financial crunch in its commercial operations by the proposed sale of 40% of its equity to Taiwan Aerospace Company. Although this deal may be sound for MD, it is not necessarily sound for the American aircraft industry and its American suppliers or for the American economy.

How should the United States respond to the internal and external challenges confronting the American industry? What trade and industrial policies should be adopted to ensure that America continues to benefit from the jobs, profits, and export earnings that industry leadership would guarantee? This chapter answers these questions based on an analysis of global competition in the industry during the postwar period. This introductory section presents a schematic overview of the logic behind the argument and summarizes the basic conclusions.

Informed policymaking in the commercial aircraft industry requires an understanding of its unique economics, which are described in the next section of this chapter. Immense technological risk and huge upfront development costs, as well as economies of scale, scope, and learning, drive the industry toward a natural monopoly with a single producer dominating the global market. In principle, such an outcome is desirable for production efficiency, but this is only one criterion for evaluating the welfare consequences of the industry's structure. Another criterion is dynamic efficiency--the extent and pace of technological change and product differentiation, both of which are of critical importance to the downstream air-carrier industry. Since the launch of a new aircraft always involves substantial risk and since the cost advantages of staying with a proven model are enormous, there is an understandable incentive for the incumbent producer to postpone innovation. In other words, given the industry's economics, there is an inherent tension between static production efficiency and dynamic efficiencies and between the welfare of the producer and the welfare of its customers.

In fact, as the evidence in Section III indicates, persistent government intervention both at home and abroad has prevented a natural monopoly outcome. Moreover, in keeping with the

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[3] In 1990, Boeing's share of market deliveries was 45% compared to Airbus' share of 34% and MD's share of 21%. Exhibit 5, Collision Course in Commercial Aircraft: Boeing-Airbus-McDonnell Douglas in 1991; Case No. 9-391-106,

analysis suggested here, this intervention has had the effect of encouraging product differentiation and technological change to the benefit of the air-carrier industry.

Throughout much of its history, the American aircraft industry has benefitted from a makeshift but nonetheless effective industrial policy. Although the goals of this policy have been primarily military in nature, it has had unintended and unavoidable spillovers on the commercial marketplace. For the reasons discussed below, indirect industrial policy support for the commercial aircraft industry is no longer nearly as important as it was even fifteen years ago. Nonetheless, because of the industry's economics, the effects of past support are long-lived. Both Boeing's monopoly of the wide-body, long-range market and its consequent position in the global industry had their roots in engine technologies and design competitions funded by the U.S. military. Similarly, MD's current difficulties can be traced to head-on competition with Lockheed for the wide-body, medium-range market, a mutually destructive competition made possible by the "life-preservers" provided to both companies by their substantial military operations.

In contrast to American industrial policy support, European industrial policy support for Airbus has had avowedly commercial objectives, although such intervention has often been defended on dual-use grounds.[4] Given the industry's economics, Airbus would not have stood a chance against American producers without massive development, production, and marketing support during its infancy. Because of scale, scope, and learning economies, a potential entrant to the industry faces much higher production costs than incumbent firms. It takes years of losses for a new firm to develop a family of aircraft and to produce them at a large enough scale to realize comparable economies. Moreover, the upfront development costs and technological risk associated with launching such a family are enormous. Together, these conditions pose insurmountable barriers to the entry of new competitors through market means. The visible hand of government was behind a new entrant like Airbus in the past and will be behind potential new entrants like Taiwan Aerospace or Mitsubishi in the future.

Harvard Business School, 1991.

[4] The Europeans often justify their subsidies to Airbus on the grounds that a commercial aerospace industry is essential to preserve the technology base required for national security needs. This justification is strikingly similar to the argument the US has used to justify its federal support for Sematech. A similar observation is made by Theodore H. Moran and David C. Mowery in "Aerospace and National Security in an Era of Globalization," CCC Working Paper No. 91-2, Center for Research and Management, University of California, Berkeley, 1991.

But why would governments be willing to assume the huge financial costs and risks of promoting a commercial aircraft industry? The answer lies in its "strategic" military and economic significance. Commercial aircraft production is strategic in the conventional military sense because of spillovers between commercial and military operations. Scope economies and technological innovation spill from one side of the industry to the other. All commercial airframe producers are also major military contractors (Table 5-3), and the two sides of the industry share an overlapping pool of subcontractors and component suppliers. The synergies between the military's emphasis on performance and flexibility and the commercial sector's emphasis on cost and reliability have been central to aircraft technology and innovation. A competitive commercial aircraft industry thus contributes to military prowess.

Complementarity between military and civilian operations also exists because both have recurrent but usually asynchronized business cycles. Without a civilian aircraft industry to keep aerospace engineers and workers actively occupied, the cost of maintaining an independent military aerospace capability with surge capacity would be prohibitive. It is no accident that the countries which boast the major commercial aircraft producers are also the biggest arms-selling democracies. Security concerns alone dictate that both the United States and Europe will continue to produce commercial aircraft. But future defense cuts and conversion ensure that a larger portion of the American aerospace capability will have to rely on the civilian sector.

The commercial aircraft industry is also strategic in the economic sense. As the evidence in Chapter 2 indicates, the industry has made major contributions to the American economy in the form of high-wage, high-skill jobs, R&D support, and exports throughout the postwar period. Some of this evidence is consistent with the proposition that the aircraft industry is "strategic" in the theoretical sense that it generates "excess rents" or higher returns to factors of production than they could earn elsewhere in the economy. Indeed, the industry is widely regarded as the best example of an industry in which "strategic," beggar-thy-neighbor, "rent-shifting" policies may improve national economic welfare. Europe's determined effort to grab a share of the lucrative global market for commercial aircraft from the United States is often understood in terms of such a rent-shifting objective.

How should the United States respond to the challenges now before its commercial aircraft industry in light of its obvious strategic significance? Unfortunately, there are no simple answers to this question. Tired nostrums based on free market ideology are strikingly irrelevant, since they are based on assumptions of perfect competition fundamentally at odds with the industry's production conditions. They are also at odds with political reality given the industry's dual-use features. Government intervention in the industry, both at home and abroad, is likely to be a mainstay of the future just as it has been a persistent feature of the past.

There is no textbook theory of optimal policy choice to guide such intervention in a global dual-use industry in which a monopoly outcome holds the promise of static production efficiencies and substantial rents for the producer but threatens the price and pace of innovation and product differentiation for the users. Moreover, the task of striking the appropriate balance between static and dynamic efficiencies and between the interests of producers and consumers is vastly complicated by national boundaries. In a single-supplier world, industry rents would accrue disproportionately to a single nation, although cross-national subcontracting arrangements might provide a mechanism for their broader distribution across a number of countries. Indeed, the actual proliferation of such arrangements during the postwar period, often the result of intense government arm-twisting, can be understood in just such terms. Even in a single supplier world, however, the government of the supplying nation would have to weigh the interests of its own producer against the interests of its consumers--a task that is complicated in its own right. From a global welfare standpoint, the task is even more daunting since it requires weighing the interests of users in other nations as well.

Given the characteristics of the aircraft industry, neither the simple textbook presumption that foreign subsidies are a gift nor the popular political presumption that they harm domestic economic welfare can be accepted at face value. As strategic trade theory demonstrates, subsidies can shift rents from one country to another. In the aircraft case, by undermining a natural monopoly outcome, such subsidies can also reduce global production efficiencies, thereby dissipating as well as shifting global rents. Depending on how subsidies affect the terms of competition between producers, rents can be further dissipated by aggressive price competition or by costly, duplicative rounds of product innovation. But while domestic producers may be harmed, domestic users may be

helped by foreign subsidies, especially those aimed at promoting product innovation and differentiation. Under these circumstances, a prudent response to foreign government intervention in the aircraft industry must be based on balancing its possible downside effects on production efficiency, producer rents, national wage and employment opportunities, national R&D and its associated local spillovers, and national security against its possible beneficial effects on users through enhanced competition in price, product differentiation, and product innovation. In short, no simple economic theory or political platitude can substitute for a detailed analysis of a particular foreign intervention and a proposed policy response. Sections III-VI of this chapter provide such an analysis to evaluate the U.S. response to past European subsidies for Airbus and to propose appropriate policy reactions to future European subsidies and to a possible joint equity venture between MD and Taiwan Aerospace.

Several conclusions emerge from the analysis. First, with recurrent intervention in the global industry as a given, the relevant policy challenge at the international level is the design of multilateral rules that regulate the most objectionable beggar-thy-neighbor and efficiency-reducing forms of such intervention. On this score, the 1979 GATT Agreement on Civil Aircraft, which eliminated tariffs and many non-tariff barriers to aerospace trade, a 1985 OECD agreement on the terms of export financing, and an informal U.S.-Europe agreement banning inducements made considerable progress.[5] These developments fostered the globalization of production in the industry during the 1980s, with beneficial effects on competition, costs, and rent-sharing.

But on the crucial issue of detailed and enforceable multilateral rules restricting subsidies, substantial work remains to be done. After several years of on-again/off-again bilateral talks between the United States and Europe, in 1991 the United States initiated two separate actions against Airbus subsidies under the general GATT Subsidies Code. In early 1992, a GATT panel ruled in favor of the U.S. position on one of these cases, which appeared to violate GATT's overall restriction on export subsidies. Then, in a stunning announcement in April 1992, the United States and Europe revealed a tentative agreement setting limits on the level, terms, and conditions of subsidies in the commercial aircraft industry. This compromise agreement recognizes a fundamental

[5] Although the Europeans have informally agreed to eschew inducements, a recent statement by an Airbus official that Airbus would "give away its airplanes if it had to" calls into question the European commitment.

reality: given the industry's underlying economics, subsidies can not and should not be ruled out altogether. The challenge is to write the subsidy rules as parsimoniously and precisely as possible to encourage beneficial innovation and competition in the industry while at the same time minimizing the risk of rent-shifting subsidies by one side or the other, with deleterious, rent-dissipation consequences for both. The agreement announced in April 1992 appears to be a major step toward meeting this challenge.

The timing of this agreement reflects the fact that the risk of a mutually destructive trade or subsidy war had grown more pronounced in recent years for two reasons. First, Airbus has reached what both the United States and Europe regard as "competitive balance" with American producers. The infant-industry justification for past Airbus subsidies no longer applies, and even Boeing, which has heretofore opposed retaliation against European subsidies, now threatens to support such retaliation in the future. The shift in Boeing's position reflects the emergence of Airbus as a credible competitive challenge to Boeing's market dominance. Second, significant excess capacity in the global industry for the foreseeable future heightens the danger that subsidies will be used in a beggar-thy-neighbor fashion. Under these conditions, both the United States and Europe stood to benefit from enforceable rules to limit the use of subsidies not only by themselves but by potential new entrants.

A second basic finding of this chapter is the limited effectiveness of national trade policy options in the aircraft industry. A recent influential book by Clyde Prestowitz cites the industry as "a prime example of how the interplay of American trade theory, trade laws, and security works to the disadvantage of American industry and ultimately of the American economy." Prestowitz also argues that the American position in the aircraft industry is eroding, "not because others produce better or cheaper airplanes, but because of the American approach to trade."[6] The implication is that if the United States had used its trade laws--primarily its anti-dumping and countervailing duty laws and its 301 relief--more aggressively to deter European subsidies to Airbus, the American industry and the American economy would have been better off. But this chapter raises serious questions about that conclusion.

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[6] Clyde V. Prestowitz Jr. , How We Are Giving Our Future to Japan and How to Reclaim It, (New York: Basic Books paperback edition, 1989) p. 404.

First, European subsidies to Airbus may have harmed American producers, but they have also benefitted American airline companies and their passengers by enhancing competition and innovation in the aircraft industry. The historical record of competition provided in this chapter suggests that these user benefits have been substantial. Second, even assuming that past European subsidies reduced American economic welfare, the evidence presented here indicates that a protectionist response to deter such subsidies would have made matters worse. Third, partly in recognition of this fact, the American producers have steadfastly opposed unilateral trade policy measures that would have invited European retaliation. Their opposition rather than concerns about the national security costs of possible trade friction with Europe has ruled out such unilateral measures. Aggressive unilateralism on the part of the United States in the aircraft industry has taken the form of words rather than actions, because this has been the preference of the American producers themselves.[7] Finally, it seems unlikely that either a unilateral trade policy action or a countervailing subsidy response by the United States would have deterred European efforts to realize what has been their remarkably consistent long-term goal of building a competitive European aircraft producer.

A third basic conclusion of this chapter is that the real error of American policy has been the error of a haphazard industrial policy, not the error of an ineffectual trade policy. Both the persistent financial weakness of MD during the last twenty years and the initial market opening for Airbus are the consequence of a disastrous and ill-advised competition among the American producers in launching the first wide-body commercial jets in the late 1980s. This competition was a reflection of the particular policy environment in which it occurred--the government's defense-oriented industrial policies influenced who the competitors were and how they competed. Since all of the American producers were major military contractors at the time, the safety net provided by their military operations and the technological breakthroughs funded by the military encouraged them to take risky decisions that the discipline of the market, even one that was highly imperfect, would not have allowed. Rather than intervening to head off these decisions and to coordinate the industry at this

[7] In recent testimony before Congress, J. Michael Farren, the Undersecretary of Commerce for International Trade, who has long been involved in the aircraft dispute with Europe, stated that the American negotiating position with Airbus has never fundamentally diverged from the position of the American industry. Moreover, throughout these negotiations

critical juncture, the U.S. government adopted a hands-off position, letting "market forces" determine the outcome, even though these forces were heavily tainted by the government's defense links with the industry. Ironically, while the European governments were working to rationalize their national aircraft producers into a coordinated pan-European venture and to target a promising niche in the commercial industry, the American government was inadvertently encouraging its producers to embark on an unsustainable, mutually destructive competitive strategy.

As noted above, the American industry is once again at a critical juncture, with MD considering a joint venture with Taiwan Aerospace as a last-ditch attempt to secure its commercial viability. This deal raises serious policy questions. Will the deal transfer sensitive military technology abroad? How will it affect the employment and competitiveness of American suppliers to the aircraft industry? Will the large Taiwanese and Asian subsidies likely to be involved violate GATT restrictions on subsidies or the restrictions that the United States and Europe have recently announced? Will the deal, which targets Boeing's lucrative monopoly in the large-size, long-range market, help or hurt the American industry and American consumers?

A basic conclusion of this chapter is that the American government should address all of these questions. Contrary to free market rhetoric, this is not simply a market deal. MD is the nation's largest military contractor and the guardian of some of the nation's most sensitive military technology, and the Taiwanese government is a major shareholder of Taiwan Aerospace and is dedicated to building a national aerospace industry. For the reasons noted in Section VI of this chapter, the Taiwanese and other Asian governments, not private Asian investors, are likely to provide the money ultimately required to finance MD's competitive strategy--a strategy which, if successful, would result in a head-on challenge to Boeing. Boeing, not without reason, sees the deal as the equivalent of the creation of an Asian Airbus.

Section VI provides both a minimalist and a maximalist package of policy responses to the proposed deal between MD and Taiwan Aerospace. The minimalist package involves the active participation of the American government to negotiate and monitor the subcontracting and technology-transfer features of the deal and to ensure that the subsidy arrangements that inevitably

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there has been substantial agreement between Boeing and MD. On some occasions, the American government has taken a harder line than the one supported by the American producers.

ensue are consistent with existing multilateral agreements and with the recently announced bilateral subsidy agreement with the Europeans. The preferred maximalist package is predicated on the argument that the government should discourage the deal because of its adverse consequences for both the American industry and the global trading system. But discouraging the deal is not enough. Without it, MD will be forced to exit commercial production altogether, at a time when its military operations are financially precarious and face further significant cuts. Under these circumstances, one option would be for the American government to do nothing, simply allowing market forces, however imperfect, to take their toll. Instead, the maximalist package argues that the government should work out a rationalization plan for the American industry, in conjunction with American producers and their domestic suppliers. According to the arguments presented in Section VI, such a plan should encompass both the military and commercial operations of the aircraft sector.

Even if the proposed deal between MD and Taiwan Aerospace falls through, the United States needs a commercially oriented industrial policy to reduce the adjustment costs and speed the inevitable process of conversion following the Cold War. Such a policy is also required to ensure that the American industry has the financial and technological wherewithal to meet the inevitable challenge of Airbus in the super-jumbo market by the end of the decade. As the Pentagon slashes its budget and ceases production of weapons prototypes, virtually all of the big military contractors are already looking to the commercial aerospace industry for their salvation. In short, the United States needs a prosperous commercial industry more than ever. The country can no longer afford the expensive defense-oriented industrial policy of the past. Nor, given the industry's economics and the certainty of continued policy intervention abroad, can it afford the soothing but largely irrelevant position that market forces alone should determine industry outcomes in the future.

II. Airframe Technology, Market Structure, and Government Involvement

The commercial aircraft industry violates every assumption of the competitive paradigm. The industry's defining characteristics are huge scale and scope economies, tremendous risk, and dramatic technological change. Under these conditions, the market is inherently imperfect, there is no presumption that market outcomes are optimal, and government intervention can have lasting effects on industry structure and performance.

Since its inception, the commercial jet airframe industry has been highly concentrated. In 1953, when Boeing was bringing the U.S. industry into the jet age, John McDonald, a leading analyst, wrote: "It is pretty clear that all three builders cannot stay in this market; perhaps not even two can make money on jets in the next ten years. The first question is which of the three, Douglas, Lockheed, or Boeing, is going to drop out."[8] Four decades later, this still describes the industry rather accurately with Airbus in place of Lockheed and MD the most vulnerable. Underlying this tendency toward a natural monopoly, first and foremost, is the technology of airframe manufacturing. Airframe technology and innovation limit the number of potential entrants, compel them to compete on whole product families, and shape their strategic interactions in successive product launches, which are ruinously risky. Product family, as the embodiment of a common set of technology, defines the airframe market structure. Product launch, as an act of innovation, successively restructures the market. The enormous cost and forbidding risk of new product launches crucially affect market conduct and performance. Analyses that do not take the central importance of innovation into account can hardly be deemed adequate.

II.1. Airframe Technology

Airframe producers integrate numerous technologies and systems, originating from various fields and industries, into ever more efficient and capable means of air transport. A modern jet aircraft consists of millions of components, incorporating a wide range of seemingly unrelated technologies: materials, propulsion, electronics, hydraulics, aerodynamics, to mention a few. The many constituent systems found in a jet aircraft are individually extremely complex. To develop a new commercial jet aircraft now requires approximately $4-$6 billion in upfront R&D expenditure. Most of this is spent on the integration of complex components rather than their separate development: prototype aircraft development consistently ranks first in research expenditures, followed by research expenditures on avionics, propulsion, and aerodynamics.[9]

Airframe technology, which can be characterized as complex system integration, has two other related features central to the functioning of the industry. One is the importance of technology

[8] McDonald, John, "Jet Airliners: Year of Decision," Fortune April 1953, p. 217.
[9] Mowery and Rosenberg, 1982. p.135.

and innovation exogenous to the industry. As pointed out by Mowery and Rosenberg: "The aircraft industry is unusual in the extent to which it has benefited from the interindustry flow of innovations that typifies the modern economy...reflect[ing]...the high degree of systemic complexity embodied in its products."[10] As a whole, outside industries like metallurgy, petroleum, and electronics, have provided a steady stream of innovations, that have substantially improved aircraft performance. Another major source of innovations exogenous to the commercial aircraft industry proper is the military sector. With its emphasis on performance and its tolerance of cost, the military side of the industry has generated many technologies with dramatic commercial applications, including the jet engine itself.

Technological uncertainty is the other central feature of the commercial aircraft industry. The performance of an aircraft design depends critically upon the interactions of the many individually complex systems it incorporates. These interactions and resulting overall performance, however, are exceptionally difficult to anticipate in advance from design and engineering data. Unexpected but crucial, even fatal, defects or deficiencies are frequently acknowledged only after test flights. Such uncertainty reflects both the complex nature of high-performance system integration and the still modest state of scientific theory regarding the behavior of key components such as materials.[11]

The technological features of the aircraft industry have important economic consequences. Aircraft manufacturing as complex system integration implies a certain cost structure. Technological uncertainty constitutes a major part of the tremendous risk that distinguishes the business. Cost and risk together explain much of the tendency toward concentration. Counteracting this tendency, however, is the exogenous stream of innovations that potential entrants often find more attractive to adopt than incumbents.

II.2. Cost Structure and Market Concentration

Substantial increasing returns to scale are another factor behind the tendency toward concentration in the commercial aircraft industry. Scale economies, resulting mainly from huge

[10] op. cit. p.103.
[11] op. cit.

development costs and strong learning effects, are significant both within a single product and across products, which are differentiated mainly by size and range. The difficulty of system integration entails huge development expenditures, which represent about two-thirds of fixed cost (Table 5-3). In addition, the complex production process results in dramatic learning effects. According to Klepper, "An essential part of learning appears in the assembly of aircraft. Craftsmanship and timing of thousands of activities are required. Such experience is embodied in the workforce and accumulates with the number of aircraft that have been produced. There is worldwide consensus that aircraft production exhibits a learning elasticity of 0.2--i.e., production costs decrease by 20% with a doubling of output."[12]

In addition to significant scale economies, aircraft production has substantial scope. Because some production stages are not unique to a particular type of aircraft, the learning effects realized in the production of one kind of aircraft can influence the marginal cost of producing another.[13] Parallel to the cross-learning effect is the "commonality game" in aircraft design. It is standard practice to spread development costs across products by using common features and parts (Figure 5.3). If a firm wants to exploit scope economies and commonalities, it must develop a family of products sharing technologies and parts.

But a product family provides the firm with more than just cost advantages. It also provides external benefits to its customers. As long as an airline carrier sticks to one basic airframe supplier--or one product family--it can realize substantial savings in terms of personnel training, maintenance and inventory. Pilots, for example, have to be certified for particular types of airplanes and require additional training to switch from one type to another.[14]

Technological uncertainty and exogenity are behind the phenomenon of product families. As indicated below, the launch of a new aircraft involves huge risk, and the more technologically innovative the product, the greater the risk. But the steady stream of exogenous innovations also means that there are always opportunities to make a significantly better aircraft soon after a new design is developed. Cost and risk dictate that firms introduce new products only over an extended

[12] G. Klepper, "Entry into the Market for Large Transport Aircraft," in European Economic Review Vol. 34, No. 4, 1990, p. 775 803.

[13] ibid, p. 777-8.

period. Both new technological opportunities and competition can motivate a firm to modify its old products for better performance or a different market niche, leading to the phenomenon of "derivatives," or improvements within a particular product family.[15]

Incremental modifications within a product family, while not "technologically interesting", can be economically important. Learning by doing extends beyond the design and production phases into the actual use of a aircraft. Through extended use the performance characteristics of an aircraft design and its elaborately differentiated but interdependent parts become better understood. This allows the full exploitation of the model's potential through incremental improvements.[16]

Scale and scope economies are significant in many industries. The commercial aircraft industry is special in that it is truly global. Development costs, learning by doing, commonality, derivatives, and learning by using add up to a cost structure whose potential efficiency scale[17] dwarfs the total world market. Dynamic scale economies do not limit the number of both products and producers so strongly in any other sector. In producing a new airplane, a firm has to sell roughly six hundred units just to break even. This usually takes at least eight years--twelve if development time is included. In the beginning of the jet age, six hundred aircraft could easily amount to half of the total market. (The John McDonald authority was mentioned at the beginning of this discussion.) Although the world market has grown rapidly since then, making room for the efficient production of additional products, the scope economies embodied in a product family continue to exceed the size of the global market. In other words, the production level required to exhaust the scale and scope economies associated with a single product family still exceed the size of global demand.

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[14] John Andrews, "Eternal Triangles -- A Survey of the Civil Aerospace Industry," The Economist, V. 295: Special Survey, June 1, 1985, p.8.

[15] Stretching the fuselage of an existing aircraft is the most common form of derivative production:

> "The carrying capacity of the airplane depends, first of all, on the capacity of the engines. As engine performance is improved, exploitation of the potential requires redesign or modification of the airframe. The simplest response, as improved engines become available, is merely to stretch the fuselage and add more seats. Indeed, as this phenomenon came to be better understood, most airplanes were deliberately designed in order to facilitate subsequent stretching." (Mowery and Rosenberg, 1982. p.124).

[16] "In the DC-8 we have an aircraft that has experienced a more than 50 percent reduction in operating energy costs over its life span on a per-seat-mile basis, as well as a [two-fold] increase in productivity...although the basic configuration has been largely unchanged and the modifications have been relatively unsophisticated compared to differences between aircraft types." (Mowery and Rosenberg, 1982. p.122-3.)

[17] The more conventional term, minimum efficiency scale or the scale required to exhaust increasing returns, is not applicable here for reasons to be discussed in the ensuing sections.

When judged solely on the criterion of production efficiency, therefore, the large jet aircraft industry tends toward a "natural monopoly."

II.3. Product Differentiation and Launch Risk

Production efficiency, however, is only one consideration necessary for evaluating the welfare consequences of a given market structure in this industry. Another consideration is the structure's effects on efficiency in the downstream air carrier industry. A complete analysis of economic efficiency and welfare in the air transport industry must include both the industry that produces commercial aircraft and the industry that uses them to provide air transport services. The productivity and quality of service in the latter industry depends on the production efficiency, product differentiation, and technological progress of the former.[18]

There are, however, underlying conflicts or tradeoffs between the efficiency needs of both sides of this beneficial market partnership. In particular, dynamic scale and scope economies in the aircraft industry limit the incentives of producers to vary their products both in terms of their size and range and in terms of their overall quality. Limited horizontal differentiation in the size and range of aircraft restricts the efforts of air carriers to realize so-called deployment efficiency in servicing the demands of different routes. Limited vertical integration in overall aircraft quality restricts their ability to choose an optimal tradeoff between capital costs and operating costs.

To some extent, market bargaining between air carriers and aircraft producers serves to resolve the conflicts between them. In particular, the incentives for product differentiation by the producers are affected by the demands and terms offered by the air carriers. Bargaining between the producers, who are trying to exploit the scale and scope economies of a particular product family, and air carriers, who are looking for greater variety, results in compromises on both sides. But this market process is highly imperfect, both because of the concentrated nature of the industry participants and because of the tremendous risk and uncertainty associated with the entry of a new product or new product family.

[18] As a result of technical progress in the commercial aircraft industry the air carrier industry has registered one of the highest rates of productivity growth both before and since World War II. Mowery and Rosenberg, 1982, endnote 1.

The launch of a new aircraft requires sizeable innovations that entail huge upfront capital costs and generate revenues slowly and only with a considerable lag. It usually takes four to five years to develop, test, and certify a new airplane. In part, the delay is the result of technological complications and uncertainties. But economic considerations also play a role. Limited and discontinuous product differentiation means that an aircraft producer always confronts a diverse set of demands from air carriers when it introduces a new model. To accommodate as many of these demands as possible, the producer traditionally experiments with dozens of "paper airplanes" before choosing a specific design for development.[19] During this experimental phase, the aircraft company works with a large number of air carriers, not just the few that are likely to become the launch customers.

The capital requirements associated with the launch of a new product are another source of tremendous risk for the aircraft producer.[20] The enormous size of these burdens can be best appreciated by comparing them with a producer's net worth. As an illustration, the development costs of the 747 were estimated at $1.2 billion. At the time the 747 program was started, the total capitalization of Boeing was only about $372 million--in other words, the development costs were 3.23 times the company's capitalization. Similarly, the development costs of the DC-10 were estimated at three times the capitalization of Douglas, the company that introduced that product.[21]

Nor does a producer quickly earn net revenues sufficient to offset its upfront capital costs for development. In general, planes are priced on the basis of an average expected cost for an initial production batch of 400-600 units. The first units are sold at a loss because the producer has not yet moved far down its learning curve. According to one estimate, a new aircraft continues to produce negative cash flow until about the seventieth unit,[22] and only if the new product turns out to be a market success.

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[19] David C. Mowery and Nathan Rosenberg, Technology and the Pursuit of Economic Growth, (Cambridge, Mass.: Cambridge University Press, 1989), p.171.

[20] Development costs amount to about 40% of the upfront capital costs, with an additional 20% going to tooling and facilities, and the remainder going to finance work in progress.

[21] These figures are taken from Office of Technology Assessment, Competing Economies: America, Europe, and the Pacific Rim, (Washington, D.C.: Government Printing Office, October 1991), pp. 15-16.

[22] Demisch estimates presented in Office of Technology Assessment, Competing Economies: America, Europe, and the Pacific Rim, p.26.

There is always a high probability that a producer may never recover the upfront investment of a new product launch. To launch a new aircraft, a producer needs to target a "hole in the market"--i.e., an area of growing demand not well served in terms of aircraft size and range by existing products. However, the demand for aircraft is highly cyclical in volume and volatile in structure; at the initial product development stage, it is very difficult to predict what the market will be like when the product is finally ready for first delivery several years later. During the production run, the market will change even further. In addition, technological inconstancies may prevent a producer, after a huge initial investment, from developing a model of the promised size and range, at the promised cost, and with the promised safety performance. Unforeseen structural fatigue caused the failure of the first commercial jet, the British Comet. The MD-11, developed by McDonnell-Douglas, is the most recent example of a new product that has failed to meet its predicted specifications. As has been the case before, the failure of the engine supplier to deliver on expected performance is the source of the aircraft's difficulties.[23]

Another uncertainty in the launch decision for a new aircraft arises from tradeoffs between its price and its performance. A producer must decide which currently available technologies to integrate into a new model. As a result of higher development and production costs, more innovative models carry higher ultimate price tags. On the other hand, more innovative models are likely to have cheaper operating costs as a result of greater fuel efficiency and reduced pilot requirements. For the air carrier, there is a major tradeoff between capital and operating costs. Fuel accounts for an estimated 56% of an aircraft's cost over its lifetime, while the aircraft's initial price accounts for 14%, with the remainder incurred for maintenance, financing, and other direct operating expenses.[24] For the air carrier, the tradeoff between capital and operating costs hinges on fuel prices and interest rates, two factors which are very difficult to predict at the time an aircraft producer begins development work on a new model.

Finally, in selecting available technologies to incorporate into such a model, the producer must choose among marginal improvements on existing technologies and truly revolutionary

[23] During the product's development, the engine supplier promised a engine capable of powering 300 passengers across 7000 nautical miles, but it was unable to meet this commitment. As a result, Singapore Airlines canceled its $2 billion order for the MD-11 and turned to the Airbus 340.

technological opportunities. As an example, the Airbus A-320 introduced the so-called fly-by-wire system as a vertical differentiation strategy. This system was a marginal innovation on existing technologies. In contrast, Boeing urged air carriers not to buy the A-320 but to wait for new models based on drastic or revolutionary technologies that would be available when the "unducted fan" engine technology matured. Unfortunately, this technology was not ready as early as Boeing anticipated and the A-320 found a product niche, largely at Boeing's expense. If Boeing's prediction had been correct, the A-320 would have been a market failure.

Development costs and production costs represent another important trade-off in product launch. If a firm allows itself the time and investment to develop a new plane--thereby incurring more risk--it can devise a significantly better manufacturing process and lower its production costs. On the other hand, if a firm succeeds in beginning delivery of a new model faster than its competitors--thereby winning a bigger share of initial orders--the resulting dynamic scale economies also provide an important cost-advantage. Since the market for any particular type of aircraft is small, a first-mover advantage often means the difference between success and failure. Consequently, a successful first move for a particular type of model has a strong deterrent effect on the entry of competing models, as has been the case with Boeing's 747 and Airbus's A320.

II.4. Industry Organization and Multiple Sourcing

Because of the tremendous risks described above, the launch of a new product entails "betting the company", as it is called in the industry. Since a firm's very existence is at stake, there is always an understandable incentive to postpone the introduction of a new model. Working against this incentive, however, is the fear that excessive caution could mean surrendering market position to more intrepid competitors. How, then, do aircraft producers handle these competing incentives and deal with the risks they confront?

In similar situations in other industries, highly risky and expensive new types of investment are often handled through vertical integration or joint ventures.[25] Indeed, vertical integration

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[24] The Boeing Commercial Airplane Company, International Competition in the Production and Marketing of Commercial Aircraft, (Seattle: Boeing Commercial Airplane Company, 1982), P.13.

[25] S.L Carrol, "The Market for Commercial Aircraft," in R.E. Caves and M.J. Roberts ed. Regulating the Market, (Cambridge, MA: Ballinger, 1975), p.164.

between air carriers, engine producers, and aircraft producers was orchestrated in U.S. industry by the government prior to the New Deal. During this phase of the industry's development, the U.S. market was dominated by three vertically integrated, transcontinental operators, including one operator built on the consolidation of United, Boeing, and Pratt & Whitney. The New Deal, however, broke up these three operators and outlawed vertical mergers.[26] Currently, the aircraft and major air carrier companies are simply too global in their operations and too influenced by national governments to make significant vertical integration a feasible alternative.

Joint ventures are used by aircraft producers to diffuse their launch risks. Successful bids for contracts by both engine suppliers and parts subcontractors usually involve significant risk-sharing arrangements. Air carriers also take on risk by placing substantial advance orders and making advance payments for new models before they are launched. Advance launch orders, however, have never been large enough to guarantee that an aircraft producer would break even.[27] Even with varied joint venture arrangements, the launching aircraft company cannot shed the enormous risks involved.

Before the mid-1970s, when foreign air transport markets and foreign aircraft producers were of minor importance to American companies, U.S. air carriers repeatedly chose not to pool their orders and guarantee the success of a single aircraft company even though they were well aware of the cost advantages of single sourcing. According to Carrol:

> "Regardless of how reasonable the natural monopoly scenario may seem, it is not the one which has actually appeared for commercial aircraft. Indeed, almost invariably at least two quite similar competing aircraft have actually been produced. Examples are...the DC-8, 707 and 880; the DC-10 and L-1011; and the DC-9 and 737.....In each generation of competition there has been a distinct winner (or least loser) who produced a large number of planes while the other producer absorbed substantial losses. Thus, not only was one producer usually able to take advantage of its learning curve, but also the price of aircraft reflected its costs (both fixed and variable) and not some markup over the average of all producers' cost."[28]

II.5. Government Involvement and Market Contestability

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[26] Mowery and Rosenberg, 1982, pp. 104-105, endnote 2, 24.

[27] Henry Milner and David B. Yoffie, "Between Free Trade and Protectionism: Strategic Trade Policy and a Theory of Corporate Trade Demands," International Organization Vol. 43, No. 2, Spring 1989, pp. 239-72.

[28] Carrol, 1975, page. 158-159.

Despite protestations to the contrary, an unbiased assessment of the historical record indicates that the United States has had a makeshift, unintentional, but nonetheless effective industrial policy toward its commercial aircraft industry. Indeed, as Moran and Mowery argue, the U.S. domestic policy framework provided important support for the civilian aerospace industry when it was in its infancy that resembled the kind that Japan provided to its infant semiconductor industry.[29] Historically, government support for the American civilian aircraft industry has taken several forms, including preferential procurement of aircraft for military purposes, support for both defense and civilian R&D in aerospace, loan guarantees, and airline regulation that fostered competition through the provision of new aircraft rather than through price.

All of the nation's commercial aircraft producers have been major defense contractors, at least at critical moments in their development. This enormous flow of federal government contracts has provided profits (and even in some cases tooling costs) that could be applied to the development of commercial aircraft. During the first twenty years of its existence, for example, Boeing ran losses on its commercial operations just as Airbus did during its first twenty years.[30] Boeing was able to sustain these losses only because of its military operations. At least through the 1960s, endemic market volatility and sub-competitive returns in the commercial market were offset by market security and often-supercompetitive returns in the military market.[31] Operations in the latter market provided an implicit subsidy for operations in the former one.

At critical moments, government contracts provided the safety net to catch a plummeting commercial airframe company. Large backlogs of these contracts furnished steady income during periods when commercial activities were depressed. Even as late as the early 1980s, for example, the U.S. Air Force bought 60 KC-10s, which were virtually identical to DC-10s (except for add-in refueling equipment) from MD. Without this purchase, the company would not have been able to

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[29] T. Moran and D. Mowery, "Aerospace and the National Security in an Era of Globalization," p. 5.

[30] OTA, Congress of the United States, "Government Support of the Large Commercial Aircraft Indutries of Japan, Europe, and the United States: Volume II," May 22, 1991.

[31] Carrol constructed a model to impute sales and profits to either government or commercial operations for the American aircraft producers. He found that commercial operations earned sub-competitive profits, while government operations earned super competitive profits. S.L. Carrol, "Profits in the Airframe Industry, Quarterly Journal of Economies, November 1972, Vol. LXXXVI, No. 4, p.547.

keep its DC-10 production line open until the market situation was good enough for development of its derivative MD-11 in the late 1980s.[32]

A second source of government support for the commercial aircraft industry has been the provision of public funds for both defense and civilian R&D programs. In 1915, a National Advisory Committee on Aeronautics (NACA) was established to fund research in generic civilian and military technologies. The National Aeronautics and Space Administration (NASA) absorbed NACA in 1958 but continued its mission. The NASA R&D budget paled by comparison to the explosion of federal funds for defense R&D in aerospace during the postwar period, but NASA continued to play an important role through its research installations and its participation in several collaborative R&D projects.[33]

Support for defense R&D during the postwar period provided much of the technology and even some of the plant[34] used by the commercial aircraft industry at critical points in its development. For example, "the Boeing 707 in its tanker version sold several hundred planes, and the 707 itself was built in a plant leased from the government. Lockheed sold commercial versions of its C-130, C-141 and C-5A. [The Lockheed 1011, DC-10] and Boeing 747 were all spawned by technical advances on the engines used for the C-5A. In short, every generation of new civilian air transport has relied heavily on technology developed for the military."[35] In the words of a recent HBS case on the aircraft industry, "by absorbing the heavy research and development costs for jet engines, jumbo airframes and wings, and advanced avionics, federal military grants allowed Boeing [and McDonnell Douglas] to move down the learning curve on commercial planes with far smaller investments of their own capital."[36]

Although U.S. policy has not been designed to guarantee successful performance in the commercial operations of American aircraft producers, R&D support, large backlogs of "safe"

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[32] "The Big Six: a Survey of the World's Aircraft Industry," by J. Andrews, The Economist, Vol.295: Special Survey, June 1, 1985, p. 10 and OTA, Government Support of the Large Commercial Aircraft Industries, P. 40.

[33] Moran and Mowery, "Aerospace and National Security in an Era of Globalization," p. 5.

[34] Of course, the benefits of new technologies financed by the Department of Defense were not restricted to American producers but were ultimately available to the European producers as well. However, the American producers had substantial first-mover advantages in both the design and use of these technologies.

[35] Carrol, 1975, p.148.

[36] Collision Course in Commercial Aircraft: Boeing-Airbus-McDonnell Douglas, 1991, Case No. 9-391-106, Harvard Business School, 1991.

military contracts, and the government's unwillingness to allow a huge defense contractor to fail completely "whatever its commercial sins"[37] have emboldened American producers to undertake risky commercial ventures and have helped them raise the considerable financial wherewithal required to do so. When a military contractor has been threatened with bankruptcy, the government has usually stepped in with a rescue operation. For example, federal loan guarantees and a favorable antitrust review encouraged the "arranged" wedding between the McDonnell and Douglas aircraft companies in 1967. Somewhat later, in 1971, Lockheed was rescued from the brink of bankruptcy by a $250 million loan guarantee. If this history is any guide to the future, and if the substantial military operations of MD are ultimately threatened by its current commercial difficulties, the U.S. government is likely to arrange some kind of rescue mission.[38]

Finally, federal regulation of the airline industry through 1980 proved to be an indirect, unintentional, but significant source of public support for the postwar development of the civilian aircraft industry. As a result of regulatory restrictions on entry and price competition, American airline carriers competed with one another on service and quality, both of which could be enhanced by procurement of new generations of aircraft models. Thus the regulated, large domestic market provided a strong base of demand for technological innovation by the aircraft producers. In the words of Moran and Mowery, "regulated air transportation in the U.S. market served as a kind of springboard for exports in a fashion similar to what strategic trade theory recommends or what Japan has practiced in other export sectors."[39]

Overall, U.S. government policy in the form of R&D support, procurement, loan guarantees, and airline regulation enhanced competition and demand in the aircraft industry. American producers did not have to bet their entire future to introduce new products; instead, they had to bet only the commercial and sometimes less profitable parts of their operations. Of course, given underlying industry economics, greater competition reduced production efficiency. All other things being equal, multiple sourcing kept production costs higher on average than they would have been with single sourcing. Moreover, to the extent that aircraft producers excessively duplicated each

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[37] Carrol, 1975, p. 162.

[38] For more on the current difficulties of McDonnell-Douglas, now the nation's largest military aircraft contractor, and possible U.S. policy responses, see Section VI below.

[39] T. Moran and D. Mowery, "Aerospace and National Security," p.5.

other's R&D efforts, resources were misallocated. But air carriers enjoyed offsetting benefits in the form of greater horizontal, vertical, and temporal product differentiation, with spillover benefits for their customers.

As a result of the dismantling of airline regulation in the 1980s, stagnant real aggregate expenditures for aeronautics research by both NASA and DOD, and an apparent reduction in commercial spillovers from military aerospace technologies,[40] American industrial policy support for its commercial aircraft industry is no longer nearly as important as it was even fifteen years ago. Nonetheless, given the production and competitive dynamics of the industry, history matters, and current market outcomes cannot be divorced from past policy intervention. For example, although military sales have become steadily less important for Boeing over time, its monopoly in the 747 aircraft and its subsequent dominant position in the industry grew out of engine technologies and design competition funded by the U.S. military. As the evidence below indicates, Boeing did bet its commercial operations on the risky 747 project, but it did so secure in the belief that its military operations--at the time a much more significant fraction of the company's total operations--would not be seriously jeopardized.

Even in its heyday, however, American industrial policy in the aircraft sector was motivated primarily by military objectives, and its spillover effects on commercial aircraft capabilities have been largely unintended. As the Lockheed case discussed below demonstrates, the U.S. government has not prevented the bankruptcy and exit of its military suppliers from commercial operations.[41] Nor, as a rule, has the U.S. government provided direct financial assistance for the development and production of commercial aircraft. The only exception was the government-financed supersonic transport (SST) program, which was initiated in response to cooperative efforts between France and Britain to build a supersonic passenger plane in the 1960s. When supersonic flight was limited to overwater as a result of environmental concerns, the estimated market became so small that the U.S. government terminated SST funding. By that time, according to the Office of Technology Assessment (OTA), approximately $1 billion had been spent, and, with additional appropriations

[40] Moran and Mowery note that high-performance avionic technologies developed for military purposes may have commercial spillovers. T. Moran and D. Mowery, "Aerospace and National Security," p.8.

from NASA, DOT, and FAA, ten of the most promising SST technologies were adapted for subsonic commercial applications, many of which found their way into Boeing 757 and 767 models.[42]

In contrast to American intervention, European intervention in Airbus--as well as in earlier, less successful aircraft programs--has been motivated primarily by commercial objectives, although these objectives have been defended on dual-use grounds. Like American commercial aircraft producers, all of the members of the Airbus consortium are also substantial suppliers of military aircraft. In Europe, as in the United States, there have been synergies and beneficial spillovers between the military and commercial operations of these companies, and many of the technological breakthroughs in one area have found a dual use in the other.

Dual-use considerations, however, are not the determining factor behind the Airbus program; commercial considerations are. Important differences in the form of policy intervention reflect the difference in European and American goals. Direct financial support has been the principal mechanism used by the European governments in the Airbus program. This support has been provided in a variety of ways, including government contracts, loans and loan guarantees on favorable terms, guarantees against exchange rate losses, equity infusions (each of the Airbus members has been or is currently government owned), tax breaks, debt forgiveness and bailouts.[43] Current widely cited estimates suggest total Airbus subsidies on the order of $25-$26 billion over twenty years.[44]

The very different experiences of Lockheed with the L-1011 and Airbus with the A300 and A310 vividly demonstrate the significance on industry outcomes of direct financial support of Airbus. These experiences are described in a recent OTA report in the following way:

> "Lockheed was a company with a strong military business and experience producing commercial transports and had learned many of the skills needed to make wide-bodied

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[41] When Lockheed's defense operations were threatened in the late 1960s by its disastrous commercial performance with the L- 1011, the government did approve a small loan guarantee of $250 million to ensure the company's survival as a defense contractor, not as a commercial producer. Lockheed never called upon the guarantee.

[42] Office of Technology Assessment, Competing Economies: , p. 90.

[43] For example, over a billion dollars of loans to develop the A300 and A310 were forgiven the German airbus partner by the German government in 1988.

[44] This includes a substantial amount of unpaid interest on government loans at subsidized rates. Testimony of J. Michael Farren, Undersecretary of Commerce for International Trade, before the Joint Economic Committee, February 27, 1992. According to Boeing officials, total European subsidies of $26 billion amount to $8 million per Airbus sold.

> aircraft in the military C-5 transport program. Airbus was a newly formed organization drawing on the technical skills of members none of which had previously designed or produced a wide-body transport. Lockheed sold 73 L-1011s during the first year it was offered. The A300 took 7 years to sell that many. During some of this period, Airbus was producing planes for inventory and financing costs. During the first ten years of production, deliveries of the A300 and A310 (a derivative of the A300 requiring additional investment) combined were almost the same as those of the L-1011. The L-1011 lost roughly $4 billion. No one knows what Airbus lost during this period, but it would be reasonable to expect the losses were at least as great as Lockheed's. Even so, Airbus shortly brought out four new models and two derivatives while Lockheed was forced to exit the commercial aircraft business.....The difference between Lockheed's fate and that of Airbus is largely attributable to the direct financial supports the members received from their governments." [45]

Most of this support has come in the form of launch aid or low-interest loans with long repayment periods (Table 5-4).[46] By the end of 1990, the governments of France, England, and Germany had provided $5.6 billion in launch aid, of which only $500 million had been repaid, and an additional $2.3 billion had been pledged for the future A330-A340 models. A further pledge of $3 billion was made by the Germany government as part of the merger between Daimler and MBB, the German member of the Airbus consortium. These total almost 75% of the development funds used in Airbus models to date.[47]

In principle, the launch aid provided by the European governments is repayable, but only if the products developed with such aid are profitable. The companies that receive the aid are not required to pay back the funds from their other non-Airbus business activities. As a result of this arrangement, government money, not company money, has borne the significant risks of product launch discussed above. Companies have not been bet-- public funds have. Public insurance against company risk has encouraged the Airbus consortium to be aggressive in the launch of new models, to exploit new markets and new technological opportunities. Indeed, as noted below, during the 1980s Airbus was more aggressive in introducing a number of new technologies than either MD and Boeing.

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[45] Office of Technology Assessment, Competing Economies: , p.196.

[46] The estimate of $25-$26 billion in total subsidies for Airbus includes the effects of subsidized borrowing rates. The European governments have steadfastly argued that the appropriate cost of capital to be used in the measurement of its subsidies to Airbus be the cost of government funds, while the U.S. has argued that it be the commercial interest rate. The latter is the rate used by the Department of Commerce to reach its estimate of $25.9 billion.

Airbus, like the American commercial aircraft producers, has also benefited from government assistance in export sales. In the United States, this assistance has come primarily in the form of export financing provided by the U.S. Export-Import Bank. During periods of weak domestic demand, when the commercial operations of U.S. producers have been threatened, such financing has sometimes been substantial.[48] The Europeans also have export credit agencies whose mission is to equal or beat the terms offered by their trading competitors. In the late 1970s when Airbus was struggling to break into the U.S. market, the United States and Europe engaged in a flurry of competitive and costly export financing. To prevent this from recurring, they worked out a bilateral agreement in 1981 that was formalized in the OECD in 1985.[49] This agreement established maximum time periods and minimum allowable interest rates that governments could offer on loans for the purchase of large commercial aircraft. Since that time, in part because of the agreement and in part because of developments in the financial market that have changed the way aircraft purchases are made, export financing has become a less important policy tool.

The European governments have also used a variety of inducements to support foreign sales by Airbus. European landing rights or additional landing slots have often been offered to foreign air carriers purchasing Airbus aircraft. But more exotic inducements in the form of elaborate counter-trade and barter deals have also been offered by the European governments, especially France.[50] Inducements have occasionally been used by the U.S. government, more often for military than for commercial aircraft sales, although the two are often related.[51] Since inducements are by their nature difficult to document much less quantify, it is impossible to determine whether they have been of greater significance in the foreign sales of European or American aircraft. About all that can be said with certainty is that neither the European nor the American government has been entirely innocent of offering inducements. However, both sides have recently desisted from such offers as a

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[47] Office of Technology Assessment, Competing Economies: , p.197. This estimate is based on U.S. calculations, but according to Department of Commerce officials, the Europeans widely agree that it is in the correct ballpark.

[48] Between 1967 and 1977, the Ex-Im Bank provided $5.8 billion in loans on $12.8 billion in export sales of commercial jet aircraft. Office of Technology Assessment, Competing Economies: , p.98.

[49] The Large Aircraft Sector Understanding (LASU) allows for loans of 10 to 12 years at rates based on the US-Treasury bond yield.

[50] For examples, see Office of Technology Assessment, Competing Economies: , p.227.

[51] It is probably not a coincidence that the El Al fleet, the national air carrier of Israel, consists entirely of American commercial aircraft.

result of an informal bilateral agreement reached in 1986 (for more information see discussion below).

Finally, although there are no explicit procurement regulations requiring European airlines to buy Airbus products over their American competitors, informal pressure working through a variety of channels, including partial or complete state ownership of national airlines throughout much of the 1980s, appears to have had some effect. Undeniably, Airbus has done significantly better with European airlines than with American airlines, but this is at least partly the result of the willingness of Airbus to design its products with the special features of the European market in mind. Indeed, the whole concept of the A300 was targeted at the high-density, short-haul European routes. Both Air France and Lufthansa have only Airbus products, even in those product categories with direct American competition--for example, from the Boeing 757. On the other hand, it is difficult to believe that European procurement preferences pose an impenetrable access barrier to American products. In 1988, for example, 1000 Boeing aircraft were in operation in Europe, compared to only 56 Airbus aircraft in operation in the United States.[52]

As the preceding discussion suggests, competition in the global aircraft industry during the postwar period has been influenced by the very visible hand of government, manipulating a number of policy tools. The following section presents a brief history of this competition with two objectives: first to demonstrate the effects of various industrial policies on market conduct and performance; and second, to show the long shadow of history in industries with huge dynamic scale economies. In particular, the historical record reveals how the implicit U.S. industrial policy contributed to the ascendance of U.S. firms in the world market in the 1950s and 1960s and to the beginning of their fall from total dominance thereafter. It also shows the effects of explicit European industrial policies, especially launch aid, on the technological choices of Airbus, and how these choices influenced the pace of innovation in the industry in the 1970s and 1980s. When these two stories of industrial policy are juxtaposed, what stands out is the pervasive influence of government intervention in the commercial aircraft industry.

III. Aircraft Innovation, Industrial Policies, and Market Conduct

[52] "How Boeing Does It," Business Week,, July 9,1990, No. 3168,pp.46-50.

The history of the commercial jet aircraft industry can be divided into two parts and four stages (Table 5-5). During the first part (1952-1972), modern air transport was developed in two stages, each of which was predicated on a breakthrough in engine technology. In the 1950s, the turbo jet engine introduced the jet age with planes like the Boeing 707 and the DC-8. In the 1960s, the turbo fan engine made possible long-range aircraft such as the Boeing 747 and the DC-10. These models were called wide-bodies to distinguish them from the single-aisle narrow-bodies developed during the first stage. Both the turbo jet and the turbo fan engines were drastic innovations that totally changed the economics of aircraft manufacturing, reversing the market positions of competing American firms and establishing American dominance in the world industry.

No such drastic technological innovations occurred during the second half of commercial jet history, which began in 1978. Instead, firms and countries competed to replace first generation aircraft with more efficient and differentiated products for the rapidly expanding global market. New narrow-bodies were first delivered in the 1980s and new wide-bodies are to be delivered in the 1990s.

There was, however, one major change in the global aircraft industry after 1978--the unmistakable emergence of Airbus as a serious economic competitor. As noted earlier, as a result of Europe's market-oriented industrial policy, Airbus achieved technological leadership in the development of commercial aircraft and determined the pace of new product launch during the 1980s. The competitive challenge posed by Airbus was felt in both the narrow-body and wide-body markets.

III.1. National Differences, Home Market Effects, and the "Jet Lag" Reversal (1952-1966)

Jet technology was a European invention. In fact, Europe gave the world its first commercial jet engine, its first jet transport, and its first supersonic transport. Before Airbus, however, European technological leadership did not translate into commercial success. Instead, the Europeans found themselves buying cheaper and better planes from moderately protected and heavily subsidized American firms. The anxiety many Americans now feel about Japanese dominance in electronics is comparable to the anxiety many Europeans felt about American dominance in the commercial aircraft industry before the launch of Airbus.

Jet technology was revolutionary in a double sense. First, it represented a break-through outside the existing technological traditions based on piston engines and propellers. Before World War II, the United States lagged behind Europe in both theoretical aerodynamics and provisions of high-speed research facilities, the advances that made jet technology possible. Instead, the United States devoted its efforts almost exclusively to development-oriented problems. Edward Constant, in his book on the subject, "attributed the failure of American engineers to originate the concept of the jet to American ignorance of the theoretical knowledge underpinning aeronautical design."[53]

Second, as a result of jet technology, the cost of aircraft development and manufacturing skyrocketed, causing revolutionary changes in firm size and market structure within and across national boundaries. Jet technology was economical only in a large, integrated market that allowed both scale economies and competitive discipline. Before World War II, through heavy government involvement[54] the U.S. had developed the world's best commercial transports and the world's best and largest commercial aviation system.[55] When jet technology arrived, this large home market gave American producers an overwhelming cost advantage *vis- à-vis* established European firms which served much smaller national markets. By the early 1960s, the pressures of scale-dominated international competition finally drove several independent European nations to see their common future in "the creation of a European aircraft industry, with Europe as its basic market."[56] In this way, Airbus was born as a response to the scale advantages of American producers.

The world's first commercial jet aircraft was the de Havilland "Comet" developed in Britain. Work on the Comet started in 1946, indicating the existence of the basic technologies well prior to American commercial efforts. The plane first flew in 1949 and entered service in 1952, more than

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[53] D. Mowery and N. Rosenberg, 1982, p.130; E.W. Constant, The Origins of the Turbojet Revolution, (Baltimore, MD: The John Hopkins University Press, 1980), p.241-6.

[54] CAB regulations and its impacts on airframe innovation:

> "Continued congressional dissatisfaction with passenger safety and regulatory policy in general within air transportation led to the establishment of the Civil Aeronautics Board in 1938. Through its issuance of operating certificates and its overseeing of airline fares, the board effectively controlled pricing policies of airlines, as well as entry into or exit from air transportation, during the 1938-1978 period. These powers were used throughout the postwar period to prevent entry into scheduled trunkline air transportation and to prevent price competition. The CAB also controlled the award of routes to airlines; in general, multiple carriers were allowed to operate in `major' city-pair markets, while less important routes often were allowed to be monopolized by a single carrier." (Mowery and Rosenberg, 1982:141)

[55] Constant, E.W. 1980:244.

six years before the first U.S. commercial jet, the Boeing 707. "Orders by international carriers were heavy. In a sense, the subsequent role of Boeing as well as Douglas in this market was saved only by the structural fatigue which the first Comet suffered."[57]

The entry of Comet provided an immediate impetus to American firms. In the decade before WWII, Douglas dominated the American market on the basis of the efficient operating characteristics of its DC-3. Other airframe producers survived mainly on military contracts. The war strengthened the relative positions of these producers, but Douglas remained dominant. By the 1950s, only four U.S. firms had the technical and financial resources to contemplate manufacturing civilian jet aircraft: Boeing, Convair, Douglas, and Lockheed. Their conduct and fortunes during this period demonstrate the importance of scale economies and government involvement in the jet age.

When Boeing started developing its 707 in 1952, it had been largely out of the commercial market for two decades. In 1949, it tried to enter the market with the Stratocruiser. Although the plane was the fastest and most luxurious airliner at the time, it was also a costly defeat. In contrast, Boeing's all-jet bombers, the B-47 and the B-52, were huge successes, giving the company a lead in jet technologies over the other U.S. firms. With such a background, Boeing "made a move in the jet-transport field that is at once daring and cautious. The move is daring in its aim of getting to the market first...and cautious in being embodied in a dual civil-military basic transport design, which can be developed in either or both directions."[58]

In contrast to Boeing, Lockheed and Douglas--the market incumbents in existing commercial technologies--decided to delay the introduction of the new jet technology.

> "After careful study of the prospects, [Lockheed] concluded that [it] could undertake either long-range jets or medium-range turboprops, but not both. Because of the British lead in jet transports, R.E. Gross [Lockheed's owner] believed the American industry would need help from the government to catch up, and when Boeing secured its advantageous position in jet bombers and tankers, the Lockheed planners decided not to compete."[59]

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[56] Report of the Committee of Inquiry into the Aircraft Industry, London, 1971, cmnd. 2538. (The Plowden Report)

[57] Almarin Philips, Technology and Market Structure: A Study of the Aircraft Industry, (Lexington, Mass.: Heath Lexington Books, 1971), p.124.

[58] John McDonald, 1953. "Jet Airliners: Year of Decision," Fortune (April, May) p.217.

[59] John B. Rae, Climb to Greatness: The American Aircraft Industry, 1920-1960, (Cambridge, MA: The MIT Press, 1968), p. 211.

In 1952, many considered turboprops commercially more promising than jets on the grounds of relative fuel consumption. C.R. Smith, President of American Airlines later explained why his prediction had been wrong:

> "I don't think anybody could have anticipated, at the time I made all the speeches about fuel consumption, that we'd get the problem cured as readily as we did. And we would not have gotten it cured had it not been a military necessity, because the military necessity brought about a tremendous expenditure of funds for that purpose."[60]

Also in 1952, Douglas undertook its first serious study of the desirability of introducing jet technology. Its report revealed the uncertain nature of market demand in an innovative industry:

> "Operational experience and cost data on the use and maintenance of engines of the size required for jet transports of the future are meager or non-existent. These cost figures will play a deciding part in the desire or ability of the airlines to absorb the jet transport into the existing traffic patterns of their individual operations and earn sufficient additional income to pay for the new equipment."[61]

Douglas decided in 1953 not to compete with Boeing in the first jet transport market. As the entrenched firm in the existing technology, Douglas wanted to keep the current equilibrium as long as possible before launching into the expensive and technologically uncertain field of jet transport.[62] Douglas intended "to be `late' and better, the later the better if the customers will hold. Their sales strategy is to make a paper jet and make no investment until they have enough orders to justify the cost of tooling..."[63]

But the customers did not hold for long. Between 1938 and 1978, trunkline air transport entry and pricing in the United States were effectively controlled by the government. Unable to compete on price, carriers considered the rapid introduction of state-of-the-art aircraft as an important marketing strategy. When one airline purchased new aircraft promising a service-quality advantage, rival carriers would not wait long in ordering new planes, since only with timely delivery of comparable aircraft could they match the challenge in non-price competition. Thus, despite its

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[60] C.R. Smith cited in Rae, 1968. p.207.

[61] Douglas Aircraft Co., Inc., Annual Report cited in Rae, 1968. p.206.

[62] Note the similarity between Douglas's reluctance to adopt a technological innovation when it was the incumbent firm, and Boeing's later reluctance to adopt a technological innovation when it was the incumbent firm, and Airbus was the entrant.

[63] John McDonald, 1953. "Jet Airliners: Year of Decision."

original preference for turboprops, in 1955 American Airlines decided to borrow heavily and order 30 Boeing 707's, which had been launched by its archrival, Pan Am.

This loss of a long standing customer to Boeing in 1955 ended Douglas's waiting. In the words of Donald Douglas: "Our hand had been forced. We had to go into the building of DC-8 as a jet transport or else give up building airplanes."[64] Douglas' entrenched position made the huge capital and risk required for their catch-up effort manageable. Indicative of its original customer base, when Douglas announced the DC-8 in 1955 ten major airlines immediately placed orders. The project was financed by the profits of the DC-6 and the DC-7 series, borrowing, and customer advance payments.[65]

American air carriers chose to have closely competing aircraft in each category. In the medium range, Pan Am actually divided its order, the largest in the industry until then, between the Boeing 707 and the DC-8. In the shorter ranges, the competing jet models were the Convair and the Boeing 720 and in the shortest range the Boeing 737 and the DC-9. The air carriers benefitted from fierce price competition among the producers on these models, competition which would have bankrupted at least some of them if not for their military business.

Convair was the last American firm to launch a commercial jet aircraft during the first round of competition. When its 880/990 entered service in 1960, the market was already preempted by Boeing and Douglas. Unable to recover its high development costs, Convair suffered monumental losses and retreated to its military business.[66] Douglas did not do much better. Price cutting below costs to promote sales of the DC-8 and DC-9 overstretched the company financially. In 1967, Douglas was forced to merge with McDonnell Aircraft, a major military contractor, as part of a marriage arranged by the federal government and supported by a federal loan guarantee. Douglas's largely civilian product line was thus complemented by McDonnell's military contracts.[67]

Thus, even the huge U.S. market proved unable to support two profitable firms in the new commercial jet business without government R&D support, military procurement, and a dose of government-led company-rationalization. The pressure toward a "natural monopoly" outcome in the

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[64] Cited in Rae, 1968. p.208.
[65] Rae, 1968. p.208.
[66] Rae, 1968. p.210.
[67] Mowery and Rosenberg, 1982, p.133; The Economist (June 1) 1985, p.7.

absence of such help was inexorable. Because of their smaller size and defense budgets, the individual European countries could not withstand the pressure. Britain, the second-largest producer of aircraft, for example, rationalized its industry into two firms, but the pressure of work-sharing seriously hindered competition between them.[68] Although British planes had good basic designs, their costs were much higher because of small production runs, and they lacked the numerous small details that made American planes more satisfactory for passenger service.[69]

Trade, of course, is a way to expand relevant market size. Some have argued that European producers were hurt because they were effectively denied access to the crucial U.S. market by the protection afforded U.S. manufacturers by the "Buy America Act".[70] Industry economics, however, probably mattered more than the 5 per cent tariff. The launch of a jet aircraft required close collaboration in design and heavy commitments in finance between a producer and its airline customers. Domestic producers thus had a natural advantage over foreign producers in forming launch partnerships with domestic airlines. A larger home market allowed a larger launch order, which then generated self-reinforcing cost advantages. Jet aircraft is a classic case in which a country's comparative advantage in international trade derives initially from production for the home market.

In the early 1960s, the aircraft industries of the individual European countries were in crisis. Even in Britain, the two commercial aircraft firms depended on the government for their very survival. But the British government simply could not maintain its massive support levels. The Plowden Report of 1965 confirmed that the aircraft industry, being high-value-added, skill-based, and capital intensive, was "exactly the sort of business activity on which Britain should concentrate." The fundamental need was to increase efficiency, to achieve competitive scale economies, and to reduce development cost. The solution, the Report argued, was comprehensive European collaboration: "a European aircraft industry, with Europe as its basic market." The Report "saw no realistic prospect" of collaboration with American firms for they had no "overriding need" for cooperation. On the other hand, the national aircraft industries of Europe all suffered from the same

[68] Keith Heyward, The British Aircraft Industry, (New York: St. Martin's Press, 1989), p.83.
[69] Rae, 1968:212
[70] Daniel Todd and Jamie Simpson, The World Aircraft Industry, (Dover, MA: Auburn House, 1986) p.194-5.

basic problem and could not survive individually. Although the report was prophetical, it took another thirteen years for the Europeans to form a binding partnership.

III.2. Drastic Innovation, Implicit Industrial Policy, and the Wide-Body Competition (1966-1978)

Developments in engine technology rather than airframe innovations have been the most important factors behind the evolution of the aircraft industry. A decade after the first jet transport, the original turbo jet engine was surpassed by the turbo fan engine, leading to a new generation of aircraft (Table 5-3-1, column 2). Like the original turbo jet, the turbo fan was a British invention; and it was first produced by Rolls-Royce. Fan engines, by pulling as well as pushing air, had the potential to generate much larger thrust than the basic turbo jet. Adding huge fans, however, caused intimidating heat, weight, and aerodynamic problems, which initially severely limited their commercial application. Again, it was U.S. military initiative and resources that solved these problems and made the turbo fan a drastic innovation depended on by aircraft-producing firms and countries.

The Pentagon wanted a new transport jet for personnel and weaponry. Boeing, Douglas, and Lockheed proposed modified versions of their existing jets. But the military pushed for a behemoth more than twice as big. With substantial defense support, in **(date-year and possible amounts)** GE finally succeeded in developing a turbo fan three times more powerful than existing engines. As a result, market competition in the commercial aircraft industry was unsettled and ultimately redefined. At the time GE introduced its new engine design, the three American airframe companies were engaged in two U.S. government design competitions: competition for a new military transport, the C-5A, and competition for the SST, a supersonic transport project introduced in response to the Anglo-Franco Concorde project. All three companies put together skilled design teams to compete on these projects and all three benefitted from government-funded R&D experience. Both the winners and the losers of the C5A competition ultimately used their design teams and government-funded technological breakthroughs to enter a new round of competition in commercial jet aircraft.

In this second stage of competition, product differentiation decisions proved more important than company differences in innovation incentives. In contrast to the first stage of competition, all three remaining American companies plunged headlong into the business of making new wide-body

jets. All three competitors correctly believed that success or failure in this round of launch competition would determine their long-term market position. Moreover, each team was already on its way to developing a wide-body jet as a result of participation in the C-5A and SST government-funded projects. Unfortunately, what appeared to be an economically rational decision for each individual company was not an economically rational decision for the industry. Even at the time, it was clear that world market demand for aircraft, while rapidly growing, could not profitably accommodate three new wide-body jets.

According to John Newhouse, who did the most comprehensive study of the wide-body competition, a medium-range, medium-size, two-engine plane advocated by American Airlines was what the market needed the most. Pushing the limits of available technology, Boeing leapfrogged this option, introducing the four-engine jumbo 747. Lockheed and McDonnell-Douglas then chose to compete head-on by introducing simultaneously two long-range trijets. "The consequences of these [launch] decisions...injured each of the three suppliers but left in their wake an opportunity for European companies to become something they had never been--a competitive threat to the Americans."[71]

The Boeing 747 proved to be the most profitable commercial aircraft ever made. Mainly as a result of its monopoly position in the long-range 747 market, Boeing has been the only profitable commercial aircraft producer during the last twenty years. Today, according to one estimate, Boeing makes $45 million on each 747 it sells for an estimated $150 million apiece[72]. Although with the benefit of hindsight the launch of the 747 looks like a brilliant business decision, by the "normal business standards" of its time the decision looked like a fatal mistake. Boeing launched the 747 without a prior market analysis. Instead, the plane was a response to a surge in exogenous technology that grew out of military specifications.[73] On the day it lost the C-5A competition, Boeing started developing a commercial version, which became the 747, even though a commercial equivalent of the C-5A was, in 1966, simply too big for the route structures of most civilian airlines.

> "Usually, a new airplane reflects the needs of the market; thus, it is a compromise--not an ideal fit for any one of the big airlines but close enough to what they think they need to be

[71] John Newhouse, The Sporty Game, (New York: Knopf, 1982), p.123.

[72] Collision Course in Commercial Aircraft: Boeing-Airbus-McDonnell Douglas, 1991, Case No 9-391-106, Harvard Business School, pp.1-2.

[73] Newhouse, 1982. p.171.

> generally acceptable. The 747 was not a compromise; the only American carrier that wanted an airplane that large was Pan Am, and it is unlikely that the major foreign airlines desired it either. But rightly or wrongly--wrongly in retrospect--they all felt that they had no alternative. The big foreign carriers were unwilling to concede Pan Am a major marketing advantage."[74]

The fact that product choice was dominated by the strategic decision of the biggest buyer reflected a major market imperfection in the air transport industry. Because of the importance of a launch order, a launch customer's power over product choice can be disproportional to its actual share of the total order or to the scale of an efficient production run. Pan Am bet its future on the 747 in the hope of achieving a competitive advantage; the gamble nearly bankrupted both Pan Am and Boeing. Between 1969 and 1972, Boeing did not receive a single order for the 747 from domestic airlines. In 1968, Boeing had 101,000 employees in Seattle. Three years later, the number dropped to around 37,000.[75] Boeing survived this disaster drawing on revenues from its successful 727--a plane with no close competitor at the cluster point of demands for narrow-body aircraft--and income from its military contracts (which between 1969 and 1972 still accounted for nearly percent of Boeing's total revenues), and by restructuring to reduce redundancy and inefficiency. Boeing became much more market-oriented as a result of its initial 747 experience and gained a lasting productivity advantage over other its competitors.

The injuries that Lockheed and McDonnell-Douglas inflicted upon themselves in the wide-body competition proved much more disastrous over the long run. In 1966, American Airlines initiated the wide-body aircraft proposal that eventually led to the Lockheed and MD decisions to develop wide-body airplanes. Based on its forecast of growth in passenger traffic, American considered a wide-body, double-engine aircraft capable of carrying 250 passengers across 2,100 miles the best fit for market needs. Lockheed started working on the wide-body jet when it received American's proposal. After losing the SST competition to Boeing at the end of that year, Lockheed put its best engineers on American's project, intending to use its SST and military aircraft experience to develop the most advanced commercial jet. Engineers from six major carriers worked as a group with Lockheed to develop exact specifications for the new wide-body jet. American and Eastern

[74] Newhouse, 1982. p.123.
[75] Newhouse, 1982. pp.169-70.

wanted a twin-engine, limited to mid-range. TWA insisted on a wide-body design capable of crossing the country without stop, even though it had already ordered several 747 for its longer routes. TWA prevailed, for reasons unclear even to the other participating airlines.[76]

> "In acting as they did, the big carriers...tied themselves to another airplane for which there was no particular need, if only because it wasn't sufficiently different from the 747, which they all had ordered...Each of the big carriers would have been helped more and harmed less by a smaller, shorter-range airplane; this was especially true when the price of fuel began to shoot up. But even in the late 1960s...it was clear that the larger part of the exuberant growth in the airline traffic was in the middle- and shorter-range routes."[77]

After Douglas merged with McDonnell in early 1967, it plunged into the wide-body competition. Developed according to a common set of specifications encouraged by a common group of carriers, the DC-10 and the Lockheed 1011 became all but indistinguishable in their basic design. For the carriers, "Lockheed had the more attractive airplane, but McDonnell-Douglas inspired greater confidence as a company."[78] All of the carriers stood to benefit by making a common choice. They knew that if they split their orders, neither aircraft would succeed and higher costs would be unavoidable. "In a divided market, some part of which would have to be shared with Boeing's 747, the less successful of the two competitors would eventually drop out, leaving its customers in the worst kind of trouble."[79] This is exactly what happened.

Against their common best interests, strategic interactions among carriers, producers, engine suppliers, and the government led to a divided market. As in other classic prisoners' dilemma situations, each participant would have been better off with a coordinated decision, but in the absence of a coordinating mechanism each chose to act in its own private interest, with negative results for everyone. The outcome was probably the most critical blow to the U.S. commercial aircraft industry in its entire history.

Neither Lockheed nor McDonnell-Douglas could have survived, let alone dared to undertake, head-on competition in their wide-body designs without their military operations. "Sales competition between the MD DC-10 and the Lockheed L-1011, the bankruptcy of Rolls-Royce (sole

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[76] Newhouse:143.
[77] ibid.
[78] op. cit. p.147.
[79] op. cit. pp.155-6.

engine supplier for the L-1011), and the C-5A contract nearly bankrupted [Lockheed]. The collapse of Lockheed was averted in 1971 only by a federal loan guarantee of $250 million." [80] But the reprieve was temporary--in 1981, Lockheed exited the commercial market for good.

As noted earlier, McDonnell-Douglas was provided a lifevest in the form of military procurement of the KC-10, a slightly disguised version of the DC-10. But the damaging effects of its decision to compete head-on with Lockheed on a tri-jet wide-body persist to this day. Jackson McGowen, who was in charge of Douglas's aircraft operations, "particularly regrets the DC-10/L-1011 competition, which he feels should not have occurred and should not have been allowed to occur."[81]

> "McDonnell Douglas would have done itself and the other parties a great favor had it withdrawn the DC-10...But the company's management judged, wrongly, that yielding the market for big trijets to a competitor would amount to a long step o ut of the commercial business. McDonnell Douglas had also been considering a second airplane--a wide-body twin. And that was the airplane to have developed. Europe's Airbus program was indefinitely shelved at precisely this moment--the spring of 1968. Had McDonnell Douglas gone forward with its twin, the Europeans would not have revived their Airbus. In an elegiac tone, Douglas's president...says: `We missed the big twin, and that's not the only thing we missed.'"[82]

Thereafter, McDonnell-Douglas watched its world market share in commercial aircraft gradually erode, and with it the base on which to fund new generations of aircraft.

As noted earlier, the wide-body competition between Lockheed and McDonnell-Douglas was a classic prisoners' dilemma. All the participants--the producers themselves, the airline companies, and the government--would have been better off with a coordinated decision to develop a single new aircraft whose characteristics were designed to meet the demands of most of the airline companies. Moreover, this was realized at the time. The problem was not one of market information; it was one of market coordination in the presence of risk and imperfectly competitive conditions on both sides of the market.

Ultimately, the outcome in this situation was a reflection of the particular industrial policy context in which it occurred. By its actions, the government influenced who the competitors were,

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[80] David C. Mowery, Alliance Politics and Economics: Multinational Joint Ventures in Commercial Aircraft, (Cambridge, MA: Ballinger, 1987).

[81] op. cit. pp.136.

what they competed on, and how they competed. First--through loan guarantees to Lockheed, an arranged merger between McDonnell and Douglas and indirect assistance channelled through military R&D proposals and procurement--the government determined who the competitors were. Second, through its regulation of fare and route structures and through its development support for the new engine technology embodied in both the L1011 and DC-10 designs, the government influenced the terms of competition for both the airline carriers and the aircraft producers. Third, the government influenced the incentives of both Lockheed and McDonnell-Douglas to engage in mutually destructive head-on competition in their commercial activities, by providing a life-preserver in their military activities. Without such a life-preserver, strong market incentives would have contained such competition. As it was, both companies were emboldened to bet their commercial operations on a highly risky venture, secure in the expectation that their substantial military operations would survive. Their links to the military indulged their willingness to take on risk in a way that the discipline of the market, even one that was highly imperfect, would not have allowed. Whatever its intent, the defense industrial policy of the U.S. government had a significant influence on corporate conduct in the commercial aircraft industry at this critical moment in its history.

Despite its pervasive and varied influence, however, the U.S. government foreswore the role of market coordinator. And in the absence of such coordination, the American firms embarked on a mutually destructive competition that provided a critical opening for a successful and intentional industrial policy by the Europeans. Because of their accumulated production, the American companies could have produced almost any aircraft at a relatively lower cost than the Europeans, but they unintentionally left a market gap between the narrow-bodies and the jumbos to Airbus Industrie, which introduced a differentiated product and initially achieved not a cost or technology but an availability advantage.[83]

Ironically, American Airlines' proposal became one of the significant inputs in the design of the first Airbus model--the A300B, a smaller version of the A300--which was officially launched in

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[82] Newhouse, 1982. p.159.
[83] Majumdar, Badiul A., 1987. p.514.

1969 by Germany and France.[84] Unfortunately, the plane's delivery hit the 1973-74 recession. But, reflecting the strength of the European commitment to the Airbus project, the company was able to weather the recession by producing "white-tails" financed with public funds. When the European economies recovered in 1975, Airbus had an inventory lead over its American competitors. Its sales in that year exceeded those of the DC-10 and the L-1011 combined.[85] The Airbus was off and flying as a real competitive threat to the American commercial aircraft industry.

III.3. Technological Uncertainties, Market Position, and the New Narrow-Bodies (1979-1984)

Boeing responded to the challenge of the A300 by simultaneously introducing two aircraft: a new jumbo twin, the 767, to compete directly with the Franco-German A300B; and the 757, a derivative of the 737, to lure the British away from the European consortium. For Britain, an alliance with Boeing was very tempting. Boeing was a major customer of the British Rolls-Royce company which supplied engines for the 747 and the main supplier of aircraft to British Air, the largest British airline company. A production alliance with Boeing would mean common rather than competitive interests for Britain's airline, aircraft, and engine makers. Ultimately, however, the British declined to accept Boeing's terms because they amounted to a subcontracting relationship rather than a real partnership. France also expressed hesitations on the Airbus project during this period and flirted with both Boeing and MD, but no alliances materialized for the same reason.

> As a vehicle to bring the British back into the Airbus consortium, the A310, a derivative of the A300B, was launched in 1979 and the work was redivided among Britain, France, and Germany. The real competition between the now consolidated European and American producers concerned the replacement of old narrow-bodies. "Following the launch of the A310, there was a debate within Airbus about the choice of the next project with which to extend further the Airbus `family'. There was some interest...in a four-engined, long-range aircraft. However, market surveys indicated that a 150 seat, `727' replacement would offer the best prospect...MDD and Boeing were also considering new projects to meet this demand, but in the event, both preferred to produce derivatives of existing aircraft as interim contestants pending the emergence of new technologies. Early in 1981, Boeing launched the 737-300, and MDD followed with a variant of the DC9, the MD80. Airbus Industrie decided it had to attack this market with a new, advanced technology A320."[86]

[84] Britain had withdrawn from the cooperative European venture in 1968 in pursuit of alliances with American producers.

[85] Heyward, 1989, pp.53-55.

[86] Heyward, 1989, pp.58.

In 1980, reflecting U.S. dominance of the world civil jet aircraft industry, American producers accounted for approximately 85 percent of the world's operational commercial jet transports.[87] fFar down on their learning curve, and with the prospect of a propfan engine promising dramatic performance enhancement over the turbofan, Boeing and McDonnell Douglas chose to develop a derivative product in the interim. In contrast, Airbus chose to innovate, introducing several new technologies including variable camber wings, active controls, fly-by-wire, digital autoflight systems, side-stick controllers, and composite materials. Of these the most important was the fly-by-wire system, which, although unproven and risky, could considerably reduce both fuel consumption and personnel requirements.[88] Boeing urged air carriers not to buy the A-320 but to wait for new models based on the drastic propfan innovation. Ultimately, this revolutionary engine technology did not materialize as the American producers had anticipated.

Airbus was the first to introduce several technological innovations in the 1980s--not because MD and Boeing lacked the requisite technological knowledge but because their market positions generated different competitive strategies. Boeing, as the incumbent producer, had a natural tendency to exploit scale and scope economies on its existing product families. For MD, the pace of technological innovation was constrained by the lack of profitability--between 1969 and 1989 it lost more than $1 billion. Its financial difficulties stemmed from its head-to-head fight with Lockheed for the wide-bodied jet market in the 1970s. It was a fight from which MD never fully recovered.

In contrast to Boeing and MD, Airbus had both the incentive to compete on new models, to neutralize Boeing's cost and price advantages on existing models, and the funds to do so provided by the European governments.[89] Without their substantial launch aid, Airbus would not have been able to leapfrog both Boeing and MD in technology, thereby gaining industry control over the pace of

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[87] W. Stephen Pipers, "Unique Sectoral Agreement Establishes Free Trade Framework," Journal of World Trade Law, Vol. 12, No. 1, January 1980, pp.221-53.

[88] The A-320 suffered several early crashes, but the underlying problems were corrected before its market had vanished.

[89] For Airbus, the problem was to persuade its government sponsors to spend another $1.5 billion while the A300 and A310 were still repaying their launch costs. The French were dedicated to an early launch and declared their support for the A320 in mid-1981. Initially, the British and German governments would not commit to an "industrial launch" of the A320. However, in 1984, when the A320 had managed to accumulate more than 90 orders, the British and Germans were finally persuaded that the market was ready, and were willing to contribute the necessary funds to launch the aircraft, which subsequently became the best-selling Airbus model.

new product launch in the 1980s. In an ironic twist of fate, MD, provided with substantial launch aid by Taiwan, may be on the brink of doing the same thing in the 1990s. This would be to the disadvantage of both Boeing and Airbus, whose market positions now dictate a slower launch strategy.[90]

III.4. Innovation Incentives, Demand Fluctuations, and the Competition of Families (1985-)

A similar pattern of differential launch behavior was apparent in the late 1980s when American and European commercial airline manufacturers competed to replace the former wide-body aircraft. All three companies believed that the airlines would want to replace their DC-10s, L-1011s, and some older 747s with new aircraft during the 1990s.[91] MD had been waiting for the right market situation to launch an upgraded derivative of the DC-10 for several years, during which its wide-body production capacity was kept open only with orders from the U.S. military.[92] In 1986, it launched the MD-11, a tri-engine wide-body jet derivative of the DC-10 technology it was designed to replace.

Backed by the European governments, the Airbus consortium had a more ambitious plan. In 1987, it launched the A-330/340 program. These big new Airbuses shared the same basic airframe. The A330 had two engines to fly 330 passengers across 4800 miles; the A340, equipped with four engines, had fewer seats but could fly over 7000 miles.

Both MD and Airbus doubted that there was enough demand for all of their proposed new planes to be profitable. Therefore, between 1988 and 1990 they held serious discussions to study the possibility of an AM300, an integration of their proposed new wide-body designs. A joint venture between MD and Airbus would have rivaled Boeing for global market share. Even more important, the integrated model under negotiation had the potential to become the first real competitor to the 747; it would fly the distance of the 747 but with one less engine. Although a partnership between MD and Airbus made both commercial and trade-political sense, no private agreement emerged despite two years of negotiations.

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[90] See Section VI for more on this point.

[91] "Global Wrap-up: Japan and Europe", edited by Stanley Reed, Business Week, August 13, 1990, No. 3173, pp.55-6.

Allegedly, negotiations broke down after the two sides failed to agree on who would build the cockpit, a critical portion of the aircraft. But alternate technological trajectories lay behind this disagreement. For each company, the negative cost-structure effects of departing from or shrinking its original product family exceeded the scale-economy benefits of merging with another product family to produce a hybrid.

The world aircraft market started a steep upturn in 1987 and interests and orders for both the MD-11 and the A330/340 intensified. MD hoped that the MD-11 would strengthen its financial and market position, and initial signs were promising. By March 1991, 377 MD-11s had been ordered, selling out the company's production capabilities through 1995. Unfortunately, the MD-11 has been plagued by both technical and engineering problems. The first planes were delivered months late, with several engineering deficiencies. As a consequence, the plane has not been able to achieve its maximum flight ranges when filled to capacity. American Airlines, the main launch customer of the MD-11, expressed great disappointment when the plane proved unable to complete its inaugural voyage in January 1991. American used the performance shortfall of the MD-11 as an excuse to refuse delivery of its full launch order at a time when the airline industry was experiencing a cyclical decline. Thus contrary to expectation, the MD-11 has not solved MD' commercial operations financial difficulties. By the middle of 1991, squeezed by Airbus competition in the commercial market and battered by huge cutbacks in its military operations, MD's survival as a commercial aircraft producer was at stake, and there was growing speculation that it would exit the industry. Its only viable alternative was to launch a new aircraft to compete directly with the Boeing 747. But the necessary funds. An infusion of private capital was not forthcoming: MD stock was taking a beating, and traditional customers like American Airlines were dissatisfied with its performance. The only option was an infusion of public funds. The question was: from whom?

Meanwhile, in 1988, Boeing reacted to the launches of the A330/340 and the MD-11 by proposing a stretchmodel of the 767-300 widebody with a 747-like hump. But its major airline customers showed scant interest in this derivative. A year later, Boeing devised an entirely new design, slightly larger than the competition's, with two big engines for efficiency and flexibility.

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[92] Wall Street Journal, "McDonnell-Douglas Must Decide Soon Whether to Stop Producing DC-10 Jets," by John Curley, May 8, 1985, p.12.

Boeing brought together eight prime customers with "design-build teams" to make decisions on features such as wings and avionics for its new 777 model. In addition, Boeing engaged three major Japanese companies to build 20 percent of the airframe for the 777. As part of this deal, the Japanese Aircraft Development Corporation (a subsidiary of MITI) agreed to fund a portion of the development costs of the project. By this arrangement, Boeing was able to at least partially offset the development subsidy advantages provided to Airbus by the European governments and to fortify its position as the dominant supplier of commercial aircraft to Japan. Boeing's strategy is also understandable as an effort to preempt a possible alliance between the Japanese and either Airbus or MD, both of whom have courted them.[93] In early 1991, Boeing took the risk of launching the 777 for production by 1995; at the time of this decision, only United had ordered the 777 as part of a $22 billion deal that included other Boeing aircraft as well.

III.5. The Government's Hand in Commercial Aircraft Competition

The foregoing brief history of postwar competition in the commercial aircraft industry shows the ever-present role of government. Competition in the industry has been greater than it would have been if market forces alone had prevailed, tending toward a natural monopoly outcome. Both the American and the European governments have directly or indirectly determined both the players and their strategies in various rounds of competition. The Europeans have done this intentionally with the regional, neo-mercantilist intent of building a world-class European firm. They have succeeded. The Americans have done this inadvertently with the intent of creating a technologically advanced defense aerospace complex. Unintentionally, but nonetheless effectively, they have supported the development of a competitive commercial aerospace complex. Nonetheless, the unwillingness of the American government to intervene in the industry for commercial objectives has taken a toll. Most dramatically, if the government had worked with industry representatives to head off the tri-jet confrontation between Lockheed and MD, the disastrous competition that destroyed one, severely weakened the other, and left the market opening critical to Airbus' first

[93] The preemptive motive behind Boeing's alliance with the Japanese on the 777 project is clearly suggested in the words of Boeing's commercial airplane President Dean Thornton who has argued that the Japanese "are going to become involved in a commercial jet program one way or another. We sure don't want them to get involved with Airbus."

success could have been avoided. But the U.S. government steadfastly refused to take on the role of coordinator even in a market where the players and their competitive strategies were a creation of public policy choices. As we shall see below, a similar unwillingness by the government to act as market coordinator under current circumstances is likely to result in a deal between MD and Taiwan Aerospace that will be deleterious to the American commercial aircraft industry and harmful to national economic welfare.

IVa. The Economic Analysis of Government Intervention in the Commercial Aircraft Industry: The Case of Airbus

As noted repeatedly throughout this book, industrial policy intervention in a particular industry can be effective in the sense of achieving its objectives or effective in the simple sense of influencing market outcomes without being welfare-enhancing. The question of the welfare-effects of industrial policy in the commercial aircraft industry has recently been raised in the context of European subsidies to promote Airbus. This question has attracted attention both because of the conflict between U.S. and Europe on the subsidy issue and because under the peculiar market and production conditions of the industry subsidies can have potentially dramatic effects on national economic welfare, shifting rents from one set of national players to another.

Two major economic analyses of the welfare effects of European subsidies to promote the entry of Airbus exist: one by Richard Baldwin and Paul Krugman and the other by Gernot Klepper. Baldwin and Krugman concentrate on market competition between a single pair of products: the Airbus 300 and the Boeing 767. They compare three scenarios with different market structures: an Airbus monopoly in which the A-300 is the only medium-size, medium-range plane available; a duopoly in which the 767 follows the A-300 into this market; and a Boeing monopoly in the absence of the Airbus entry. They assume that Airbus received an implicit subsidy from the European governments in the form of a required rate of return on investment that was lower than that facing

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Meanwhile, Airbus Managing Partner Jean Pierson has stated that Airbus might bring the Japanese in on its 350 project during the second half of the 1990s.

Boeing.[94] They estimate that this subsidy amounted to about $1.5 billion of European taxpayers' money in 1974 prices.

According to Baldwin and Krugman's simulation model, which rests on a number of highly restrictive and questionable assumptions,[95] European subsidies to promote the entry of the A-300 had the following welfare effects: the rest of the world gained unambiguously due to an increase in consumer surplus attributable to lower aircraft prices and lower airfares; the U.S. lost unambiguously because Boeing's losses outweighed the gains of American consumers; and the welfare effects for the Europeans were ambiguous, sometimes positive and sometimes negative depending on the parameter values used. Despite such mixed results, Baldwin and Krugman conclude that "the A300 project constituted both a beggar-thy-neighbor policy and a beggar-thyself policy for Europe."[96]

This conclusion is too strong to be warranted by the questionable and sometime unrealistic assumptions on which it is based.[97] One such assumption stands out as especially inappropriate to the underlying issue of whether European intervention subsidizing the entry of Airbus was economically rational. Baldwin and Krugman overlook an essential characteristic of commercial aircraft production--namely, economies of scope between one aircraft model and a whole product family. The A300 was only the first of a family of Airbus products and technological breakthroughs that would not have been possible if the European governments had not initially subsidized the entry of Airbus. Any analysis of the economic viability of this strategy requires a full accounting of the costs and benefits of the A300 and of the entire family of products and learning it spawned.

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[94] This assumption, like the many others that are needed to generate the Baldwin-Krugman simulation results, is questionable, in part because there is no reason to assume that the cost of capital to Boeing and to Airbus would be the same in the absence of government intervention. American companies tended to pay a higher cost for investment funds than many European companies throughout the 1970s and 1980s, even when government intervention was not an issue.

[95] These assumptions include: the absence of any linkage between competition in the A300 and Boeing 767 markets and the markets for other aircraft produced by Airbus and Boeing; the exclusion of McDonnell-Douglas as a potential competitor; and the assumption that market conduct can be modelled as a Cournot competition between producers of a homogeneous product.

[96] Robert Baldwin and Paul Krugman, "Industrial Policy and International Competition in Wide-bodied Jet Aircraft," in Robert E. Baldwin, ed., Trade Policy Issues and Empirical Analysis, Conference Report, National Bureau of Economic Research, (Chicago, London: University of Chicago Press, 1988) pp.68-69.

[97] Baldwin and Krugman qualify their conclusion in the following way: "Given the degree of simplification necessary to produce a tractable model, it is difficult to base policy conclusions on our results." However, their more provocative statement is commonly cited without qualification.

A recent, more sophisticated study of economic rationality by Gernot Klepper attempts to remedy the shortcomings of the Baldwin-Krugman study by incorporating scope economies.[98] Like Baldwin and Krugman, Klepper's modeling approach suggests that any assessment of the wisdom of government policy in an inherently concentrated industry requires an assessment of its effects on competition. Klepper models competition among three product families in short, medium, and long range market segments. He compares the three scenarios with different possible market structures: a Boeing monopoly, a Boeing-MD duopoly in the absence of an Airbus entry, and a Boeing-Airbus duopoly. The calculated welfare effects differ considerably depending on which of three no-Airbus scenarios is chosen as the benchmark. Klepper concludes that government supported market entry of Airbus as an anti-monopoly policy yields higher consumer welfare, but overall welfare is lower due to large losses in producer surplus. In other words, the entry of a new competitor benefits consumers by lowering prices but hurts producers by reducing their production scale and increasing their costs. The bottom line is the same as that in the Baldwin-Krugman study--namely, that under most scenarios European subsidies to promote the entry of Airbus were not welfare-improving and hence not economically rational.

There are two common shortcomings of the Baldwin-Krugman and Klepper studies, the first concerning their question and the second concerning their methodologies. First, the question of whether policies to promote the entry of Airbus were economically rational in the sense that they increased static economic welfare is moot. Whether economically rational in this particular sense or not, these policies cannot be reversed. The entry question has been decided, and on political, military, and technological grounds as well as economic ones.

Second, the welfare methodology used by these researchers is inadequate even for their purpose of analyzing the entry question on narrowly economic grounds. Product-level scale economies and product differentiation risks tend to generate technological conservatism at the level of the entrenched firm, which in turn retards industry-level innovation and efficiency. In an industry, such as the air transport sector, where impressive productivity growth is realized mainly through innovation, the economic welfare consequences of government subsidies cannot be

[98] Gernot Klepper, "Entry into the Market for Large Transport Aircraft," European Economic Review, *Vol. 34, No. 4, pp. 775-803.*

adequately measured by their effects on static production efficiencies, prices, and rent distribution alone. A reliable determination of whether subsidies for Airbus were economically rational requires an evaluation of the effects of the entry of Airbus on the pace and direction of innovation in the aircraft industry and on the resulting benefits for air carriers and their passengers. The brief history of the last section indicates that these effects have been substantial.[99]

Overall, this evidence supports a more tempered conclusion than that reached by Baldwin-Krugman or Guernot Klepper about the effects of European subsidization of Airbus on American, European, and global economic welfare. These subsidies may have been at least a partial gift, not simply because they allowed Airbus to charge lower prices but also because they allowed Airbus to launch a new family of models filling the hole left by McDonnell-Douglas and Lockheed in the mid-range market and embodying technological innovations that Boeing, the incumbent firm, was disinclined to make on its own.

Even before Airbus became a serious market contender, competition among McDonnell-Douglas, Lockheed, and Boeing was possible only with substantial U.S. government support for each of them. A similar conclusion applies to European support for Airbus. In particular, Airbus has gained over McDonnell-Douglas on the basis of differentiated and technologically superior products made possible by European launch aid. In short, the evidence presented in this chapter indicates that government subsidies, whether in the United States or in Europe, have made the aircraft market more competitive and more innovative than it would have been otherwise. In the absence of a more formal modelling effort, it is impossible to conclude that the overall welfare effects of such subsidies have been positive. But there should be no presumption that they have been negative as American critics of the Airbus program have asserted.

[99] Mowery and Moran also argue that sales competition among the aircraft producers, spurred by the technological innovation strategy of Airbus, has produced sustained R&D races in the industry. According to them, rivalry between the Airbus A300 and the Boeing 767 led to vigorous investment in R&D to gear up for the subsequent round of competition between the A330/340, the MD-12, and the 777. See Moran and Mowery, "Aerospace and National Security."

V. Trade Friction in the Aircraft Industry

Huge scale and scope economies make exports important for U.S. commercial aircraft companies. Even before the 1970s, about one-third of all the commercial aircraft produced in the United States were sold to foreign buyers, and trade has become steadily more important since then. Trade has also been critical to the success of European efforts to build a competitive commercial aircraft capability. The European governments and companies cooperating in the Airbus venture recognized from the outset that exports were essential to realizing the global scale required for sustainable production costs. Of particular importance were exports to the large American air-transport market, the base of American competition (Table 5-6,7 and Figure 5-4,5).

In addition to their common interest in unfettered access to one another's markets and to other major global markets, American and European producers share a common interest in removing barriers to joint ventures, subcontracting, and offshore procurement of components. Again, this interest is rooted in the special features of the aircraft industry. The links between commercial aircraft companies and national defense establishments as well as the effects of economies of scale rule out significant foreign direct investment as a substitute for trade in this industry. Therefore, trade flows, not investment flows, determine the penetration of global markets. Cross-border production arrangements, which stop short of foreign direct investment but take the form of elaborate joint ventures and subcontracting deals, have become increasingly attractive to producers as ways of improving access to foreign markets and cooperating with would-be competitors.[100] In addition, foreign sourcing of components offers traditional cost advantages, which become more attractive as competition intensifies. Finally, in more recent years, as the development costs and technological challenges of launching new aircraft mount, producers have scrambled to find foreign partners willing to provide some of the development capital and to share both the financial and technological risks.

[100] According to T. Moran and D. Mowery, the rationale for development and production "alliances" in both military and civilian aerospace contains a large element of deliberate constituency-building to gain political as well as commercial backing from industrial and labor actors in the target market. For example, the high (albeit declining) American content of Airbus aircraft aids the European consortium in its efforts to penetrate U.S. markets. Similarly, Boeing's choice of a European engine producer like Rolls-Royce or a Japanese partner like Mitsubishi, yields benefits in foreign market access. T. Moran and D. Mowery, "Aerospace and National Security," p.27.

The shared interests of both the American producers and the emerging European producers in freer trade proved to be a stimulus to the successful negotiation of the 1979 GATT Agreement on Trade in Civil Aircraft. But conflicting rather than shared interests were behind the lobbying efforts of the U.S. producers to get such an agreement into the GATT Tokyo Round discussions in the first place. Ironically, these conflicting interests were never addressed.

By the early 1970s, the American companies were already expressing concern about the fact that the Europeans have achieved high levels of sophisticated production capability proceeding with direct government backing and assistance. By 1978, concern had turned to alarm as a result of Airbus sales in East Asia, the Middle East, and, even more dramatically, the United States itself. In the latter case, Airbus successfully penetrated the monopoly of the American producers at home by offering Eastern Airlines "an offer it would find too attractive to refuse." The deal included a six-month free trial period, an operating cost guarantee, and extremely favorable export credit terms. The risk to Airbus from this deal was substantial. Should the A-300 fail to satisfy Eastern, it could return the aircraft, levying damaging, possibly fatal, consequences on Airbus' reputation. But the benefits were equally substantial: should Airbus succeed with Eastern, it would gain a foothold in the heretofore impenetrable American market. As the American producers were quick to point out, the financial costs of the deal to Airbus were covered by European subsidies.

At the time of the Airbus offer to Eastern, C. Fred Bergsten, then an official at the Treasury Department, proposed a countervailing duty to offset the subsidies offered by the Europeans.[101] A large duty, speedily introduced, might have been a serious deterrent to future European efforts to subsidize Airbus sales. In addition, the Europeans were still heavily dependent on American commercial aircraft, and the risk that significant retaliation could harm American producers was relatively low. In short, the conditions for using the nation's countervailing-duty (CVD) law as a remedy to offset the subsidies on the Airbus sale and to deter their future use were relatively auspicious in 1978. Subsequently, as Airbus became a more important competitor, the threat of European retaliation to CVD relief intensified, and American producers became reluctant to propose its use.

[101] Bergsten made his proposal to then Treasury Secretary William Blumenthal.

Ultimately, the proposal to use CVD relief in 1978 was blocked not by the aircraft producers but by Eastern Airlines, which appealed to Treasury Secretary Blumenthal to reverse his initial support of the proposal. Eastern CEO Bowman made the request directly, arguing that Eastern and other American air carriers stood to benefit from Airbus' aggressive selling tactics.[102] This was undoubtedly true, but an informed policy judgment required that these benefits be weighed against the costs to U.S. producers and against the foregone benefits of deterring future rounds of Airbus subsidies. No such judgment was made, and a promising opportunity to moderate future European subsidies was lost.

Meanwhile, American producers became more vocal about the ominous and unfair nature of European export subsidies and called for a halt to "predatory export financing." Gradually these complaints broadened to include multifaceted industrial policy supports for Airbus and their adverse consequences for Europe's trading partners. The American companies were careful, however, not to ask for trade protection as a remedy, since they enjoyed substantial export sales to Europe. Instead, U.S. producers continued their traditional policy of requesting R&D support, tax credits, and more EX-Im Bank financing to match the sales terms offered by the European governments. At the same time,

working through the U.S. aerospace advisory committee for the Tokyo Round discussions, the American producers called for a sectoral GATT agreement to address the specific issues underlying trade conflict in the aircraft industry.

The American objective, in the words of its negotiating representative, was to have a "unique sectoral agreement establish[ing] a free trade framework."[103] In the minds of the American negotiators, this meant an agreement that effectively constrained European support for Airbus. In other words, what the Americans wanted was not only a "free trade" agreement that eliminated traditional trade barriers but also a "free market" agreement that constrained European industrial policy support for the aircraft industry. The United States won the first point, but ultimately lost the second.

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[102] C. Fred Bergsten supplied this information.

[103] W. Stephen Pipers, "Unique Sectoral Agreement Establishes Free Trade Framework," Journal of World Trade Law, Vol. 12, No. 1, January 1980, pp.221-53.

The 1979 GATT Agreement on Civil Aircraft is summarized in Table 5-8. Because of their common interests in freer trade, the Americans and the Europeans were able to concur on eliminating a wide range of border and non-border trade barriers, including tariffs, quotas, preferential technical standards, closed procurement arrangements, mandatory subcontracting arrangements, and export subsidies.[104] A Committee on Trade in Civil Aircraft was established for continuing consultation among the signatories on the agreement's implementation. A broad coverage of a wide range of trade barriers allowed the signatories to reach a mutually beneficial outcome.

The 1979 GATT Agreement on aircraft was a tremendous success, as far as eliminating traditional trade impediments. Substantial liberalization of trade in aircraft resulted from the Agreement, and it had dramatic effects on cross-national subcontracting and sourcing of components, both of which exploded in the following years, changing the organization of the global aircraft industry forever. According to Mowery and Rosenberg, "U.S. exports of aircraft parts and components grew rapidly after the signing of the agreement. Exports of components and other parts grew at an average annual rate of 36% from 1977 to 1982, from roughly $2 billion to roughly $4 billion. Exports of aircraft engines increased from slightly more than $200 million to more than $800 million during the same period."[105] In response to the growing European threat, American producers also began to take greater advantage of international cooperative production arrangements, which were rendered considerably more attractive by the elimination of trade barriers.[106] Overall, the Department of Commerce estimates that through the end of 1991 the 1979 Agreement has saved as much as $1 billion in tariffs and other duties for American companies in the aircraft and parts industries.[107]

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[104] Because the OECD had been concerned with aircraft export financing for some years and was negotiating an agreement toward that end, the GATT agreement did not address this issue. As noted earlier, a companion agreement on export financing first between the U.S. and Europe and later within the OECD significantly reduced trade friction and the prospects of mutually destructive export subsidies.

[105] Mowery and Rosenberg, 1989, p. 196.

[106] It is extremely unlikely that any large jet aircraft will ever be designed or built solely within national boundaries again. According to the MIT Productivity Commission Report, Boeing has state flatly that it will no longer consider such huge undertakings without foreign partners.

[107] Estimate provided to the author by Department of Commerce.

Why, then, did the 1979 GATT Agreement fail to head off worsening friction between the United States and Europe in commercial aircraft? The answer is simple: it failed to address the competing industrial priorities and policies behind this friction. International rules can moderate trade conflict when the parties to the conflict can find common ground or mutual interest; they cannot moderate conflict when the interests of the parties are fundamentally antagonistic. Both the Europeans and the Americans stood to benefit from reducing barriers to trade in aircraft, but their interests were at odds over the question of industrial policy support for Airbus. The Europeans were fervently committed to such support; the Americans adamantly opposed. Given this conflict, any compromise agreement on the question would necessarily be vague, imprecise, and ultimately unenforceable.

In the negotiations leading up to this compromise, the Europeans requested language and a set of rules based on the concept of "managed competitive balance." They sought rules that allowed subsidies to the extent required to produce aircraft technically and economically competitive with U.S. products.

The Americans were steadfastly opposed to Europe's request. Although the United States endorsed the concept of assuring "equal competitive opportunities" for both American and European producers, it would not condone government intervention aimed at establishing competitive balance. Government policy, according to the U.S. negotiating position, should establish an open competitive environment, but it should not arrange competition so as to influence its outcome.[108] This high-minded principle conveniently overlooked the effects of previous U.S. policy on the competitive position of the American producers at that time.

Despite intense American pressure, the Europeans were only willing to agree to rules on government support that were limited in scope, vague in stipulation, and weak in enforcement. Moreover, even in those instances in which the Europeans bowed to U.S. pressure for more precise language, the United States won a victory in words, not intent. For example, although the Europeans lobbied for a vague statement that the "the signatories to the Agreement have the firm intention to avoid attaching inducements" to aircraft sales, they ultimately agreed to the U.S.-sponsored statement that "signatories agree to avoid attaching inducements of any kind." But, the American

[108] W. S. Pipers, "Unique Sectoral Agreement Establishes Free Trade Framework", 1980, p. 233.

negotiator, mindful of the European attitude concerning inducements, warned: "If future practice follows past, the U.S. government may well want to review its "hands-off" policy regarding civil aircraft marketing efforts in export markets."[109]

The issue of industrial policy was even more controversial. The Europeans insisted on language that reflected their position as a condition for signing the agreement. Table 5-8, which contains most of the sections of the 1979 Agreement covering industrial policy issues, reveals the ultimate hollowness of the commitments the Europeans were willing to make. According to the Agreement's Preamble, many of its signatories (read the Europeans) view the aircraft sector as a particularly important component of industrial policy, and while they will seek to eliminate the adverse effects on trade resulting from government support in civil aircraft development, production, and marketing, they recognize that such support, of itself, would not be deemed a distortion of trade. This language is in fundamental disagreement with the U.S. philosophical position on subsidies.

Article 6 of the Agreement, which deals explicitly with government support to the industry, is likewise a vague compromise that conforms to Europe's underlying position. According to this Article, the signatories to the Agreement affirm that in their participation in, or support of, civil aircraft they shall seek to avoid adverse effects on trade in civil aircraft[110] (in the sense of Article 8.3 and 8.4 of the 1979 GATT Agreement on Subsidies and Countervailing Measures), but they recognize the widespread government support in aircraft and the desire of the producers of all Signatories to participate in the expansion of world civil aircraft markets. The Agreement also recognizes the principle that "aircraft pricing should be based on a reasonable expectation of recoupment of all costs, including nonrecurring program costs and identifiable and prorated costs of military research and development on aircraft," but there is no explicit or enforceable ban on pricing which violates this principle. In short, the Agreement accepts the legitimacy of national industrial policies in the aircraft industry and establishes no precise or enforceable restrictions on either the

[109] Ibid, p.238.

[110] The adverse effects on trade identified by the agreement include: injury to the domestic industry of another signatory; nullification or impairment of the benefits accruing directly or indirectly to another signatory under the GATT; serious prejudice, including the threat of it, to the interests of another signatory.

kinds or extent of such policies. Nor did the signatories to the Agreement disavow the use of such policies--rather they committed only to "seek to avoid" their adverse effects on trade.[111]

If the American producers left Geneva with enthusiasm for the 1979 Agreement, their enthusiasm was quickly dashed by the growing success of the Airbus 300 in the global market for wide-bodied aircraft between 1981 and 1985. During this period, sales of the Airbus 300 exceeded sales of both the DC-10 and the L-1011--in some years the A-300 captured 50% of the orders for wide-bodied jet aircraft. As McDonnell-Douglas and Lockheed landed devastating blows against one another in their head-on competition between the DC-10 and the L-1011--a competition that clearly violated the pricing principles of the 1979 Aircraft Agreement--the Airbus 300 gained market share at the expense of them both. Ultimately, a much weakened Lockheed exited commercial aircraft production altogether in 1981.

The global market slowdown for commercial aircraft in the early- to mid-1980s sharpened the conflict between the American and European producers. With U.S. exports of civil aircraft down by as much as 50% in 1982-84 over their 1979-80 peak (Figure 5-5), U.S. producers complained bitterly about the unfair pricing strategies of Airbus and the unfair government subsidies that made them feasible. Even Boeing, which successfully parried the competitive challenge of the Airbus 300 by launching the 757 and 767 models, circulated a report alleging that Airbus was not covering its costs and was benefiting from massive government subsidies.

Boeing's concerns mounted when Airbus realized its second successful penetration of the American market with a major sale to Pan Am in 1984. This sale was of great symbolic significance since Pan Am was a key Boeing customer and also had a reputation as the foremost launcher of new aircraft in the American air transport industry. As if these inroads by the Airbus 300 were not enough, in 1984 Airbus announced its decision to launch the A320 with the help of its supporting member governments. Unlike the A300, which was built on existing American technologies, the A320 embodied significant technological innovations that made it a serious competitive challenge for Boeing. It was one thing to watch smaller American producers lose market share as a result of a

[111] The Agreement recognized that these adverse effects could arise through: the effects of the subsidized imports in the domestic market of the importing signatory; the effects of the subsidy in displacing or impeding imports of similar aircraft into the market of the subsidizing country; or the effects of the subsidized exports in displacing the exports of similar aircraft of another signatory from a market in a third country.

wise European decision on the size and range of the Airbus 300, but it was quite another to watch Airbus challenge Boeing with a new technology. The announcement of the A320 was also significant because it confirmed a commitment among the European governments--including the British government, which had withdrawn from the A300 project--to continue collaboration in commercial aircraft for the foreseeable future.

Friction between the United States and Europe over the A320 challenge accelerated in 1984 and 1985 as Boeing and Airbus competed for a large contract with Indian Airlines.[112] In June 1984, Indian Airlines had signed a letter of intent to buy 12 757 aircraft from Boeing with the option to purchase an additional 13. But Airbus managed to reopen the negotiations, offering to deliver its new A320 at a substantial price discount by 1989 and to lease Boeing 737s and Airbus 300s to Indian Airlines in the meantime. Overall, Airbus offered financing to cover an estimated 85% of the cost of the purchase, an amount permissible under the OECD export financing agreement. Airbus eventually won the bid away from Boeing in September 1985.

Boeing and American officials were outraged. Airbus was accused of violating Article 6 of the 1979 agreement, which required pricing on a reasonable expectation of recoupment of costs. In addition, the Americans accused the Europeans of violating the agreement's ban on inducements amid rumors that as part of the Airbus deal the French government had promised to provide technical assistance on cleaning up the Ganges River, to support India's efforts to secure additional soft IBRD loans, and to accelerate the delivery of French Mirage jets to India. Supporting these allegations was the fact that French officials had made several high-level "multiple-purpose sales calls" in the months prior to the announcement of the Airbus contract.[113]

This announcement occurred in the context of growing Congressional and business pressure in the United States for a tougher unilateral trade policy to confront "unfair" foreign trading practices. On September 23, 1985, President Reagan delivered a much publicized speech on trade policy in which he defined the U.S. objective as "fair trade" and announced his support for using Section 301 in unilateral pursuit of this objective. In a follow-up press conference, the President delineated various alleged violations of trade agreements by the nation's trading partners. Airbus

[112] The following two paragraphs on the Air India deal are based on David B. Yoffie, International Trade and Competition: Cases and Notes in Strategy and Management, (New York: McGraw Hill, 1985), pp.332-53.

was number three on the list. Soon thereafter, Congress began considering action to bring a special 301 case against Airbus.

Meanwhile, Boeing openly accused the European governments of subsidizing Airbus to the tune of $10 billion and urged Washington to pressure them to disclose fully the extent of their subsidies and the financial results of the Airbus consortium. Boeing lobbied for prompt negotiations with Europe, but stopped short of asking the President to file a 301 action.[114] Europe represented Boeing's largest foreign market, and Boeing was unwilling to risk retaliation by the European governments in the event of a formal 301 complaint.[115] If credible action was to be taken to convince the Europeans to desist from subsidies and unfair inducements for Airbus, it would have to be initiated by the U.S. government.[116] Moreover, given the politics of trade-policy making in the United States, any such action would have to be acceptable to the American producers.

But the government itself was divided on the issue of what to do. The State Department argued against any action because it might upset broader geopolitical relations with the Europeans and jeopardize national security interests.[117] According to Prestowitz, other government officials argued against doing anything on the grounds that European subsidies for Airbus were a gift for the American airlines buying them. Still other officials argued that the aircraft producers should file anti-dumping suits on their own behalf, something which they were reluctant to do given their fear of retaliation and their desire to maintain access to Europe's market. Ultimately, the strike force created by the President in the fall of 1985 to combat unfair foreign trading practices declined to act against Airbus. In the Airbus case, the "aggressive unilateralism" of the United States and its ability

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[113] D. Yoffie, International Trade, 1990, p.338.

[114] Boeing's President Dean D. Thornton also stated publicly that "I don't support any form of subsidy for us, even if Airbus continues to receive subsidies and political support." Quoted in Aviation Week and Space Technology, December 16, 1985.

[115] The contrast between Boeing's unwillingness to file a 301 petition against Airbus and the SIA's willingness to file a 301 petition against the Japanese semiconductor companies is instructive. In the former case, Boeing's dependence on the European market militated against a 301 action, while in the latter case, the SIA was not dependent on the Japanese market because of the very access barriers which were at the heart of the American industry's 301 arguments.

[116] American air carrier companies were also not in favor of protectionist measures against Airbus, fearing the effects of a virtual Boeing monopoly in commercial aircraft.

[117] "In the fall of 1985, when the President created the strike force to act against unfair trade, it declined to act against Airbus. Secretary of State Schultz usually did not attend the strike force meeting, but he did attend the one on the Airbus in December 1985. Any action against the Airbus, he said, would upset our relations with the Europeans and most especially with the French. This would harm our national security and therefore should not be considered." See, Clyde Prestowitz, How We Are Giving Our Future to Japan, 1989, p.405.

to "bully its trading partners" proved to be more talk than action throughout the 1980s. But tough talk rather than tough action was all the American industry was willing to tolerate for fear of retaliation.

Since 1986, the United States and Europe have held intermittent bilateral talks on their aircraft dispute. During this period, the United States has repeatedly considered initiating 301 action or CVD relief against Airbus' subsidies, but these options have been judged unattractive by the American producers. Instead of initiating such unilateral actions, the United States, like Europe, has preferred to work toward a bilateral deal to extend the 1979 Aircraft Code. This approach has served Europe's desire to avoid a formal GATT review of its subsidy practices, a review which would involve the disclosure of sensitive national information. Under Airbus consortium rules, complete information about the amounts, terms, and conditions of member government support is not regularly exchanged among the four partners. Indeed, the lack of information has been a formidable impediment to the progress of the bilateral talks between the United States and Europe.[118]

[118] According to an official at the Department of Commerce, U.S. pressure on the Europeans to reveal subsidy information has actually been a prod from which they have benefited, since, in the absence of such pressure, there was insufficient information exchanged among the Airbus governments themselves. According to this official, as a result of U.S. pressure, Airbus has enacted some organizational and accounting changes that have made it a more commercially oriented operation.

The United States has tended to prefer a bilateral solution to a formal GATT panel in part because it is not obvious that a complaint against European subsidies in the context of the vaguely worded 1979 Aircraft Code would be successful.[119] Europe has repeatedly expressed the view that if the United States were to lodge a formal GATT complaint, it would be laughed out of court for two reasons. First, because their subsidies are supposedly repayable, the Europeans believe them to be GATT-consistent.[120] Second, the 1979 Agreement only requires that each side seek to avoid government support that has "adverse effects" on trade. Given the continued dominance of Boeing in the global marketplace, the Europeans believe that it would be difficult to demonstrate such "adverse effects." On these two grounds, the Europeans have steadfastly maintained that their development subsidies do not violate the 1979 GATT agreement.

The bilateral talks between the United States and Europe have revealed the major points of disagreement between them, often in a heated atmosphere of charges and countercharges. Table 5-9 summarizes these points as of the end of 1991. Many of them revolve around technical questions such as how to determine the boundary line between the development phase and the production phase of a new aircraft model and which interest rate to use to calculate the subsidy component of a European loan to Airbus. But the most important point of disagreement concerns the extent of allowable public launch aid. In earlier rounds of talks, both sides agreed to informal bans on inducements and production subsidies, although there is as yet no agreement on when development ends and production begins. Neither ban covers launch aid, however, which has been the largest component of European support for Airbus. According to American estimates, which the Europeans do not dispute, public funds covered 100% of the launch costs of the A300, approximately 75% of the launch costs of the A320, and a comparable level is committed for the A330/340 program currently in operation.[121]

Over the course of the 1986-1991 negotiations, both the European and American sides showed signs of willingness to compromise on the launch aid question. The initial American

[119] According to the Europeans, even if the US had brought a complaint against Airbus subsidies to the GATT in 1986, before the global market took off, it would have been unsuccessful. In that year, Boeing, with over 1000 aircraft in service in Europe compared with only 56 Airbuses operating in the US, made record profits and sales. "America Turns Up the Heat On Airbus", The Economist, July 5, 1986, Vol. 300, No. 7453, p. 62.

[120] According to J. Michael Farren, it is extremely unlikely that any of the past subsidies to Airbus will ever be repaid. Certainly, there has been no evidence of repayment so far.

position that European subsidies were unfair and should be terminated has given way to a more realistic position that such subsidies should be reduced and capped, but not eliminated altogether. Gradually, American negotiators have come to accept the validity of the European argument that past subsidies were defensible on infant-industry or "competitive inequity" grounds. Now, however, Airbus has become an adult, and the original European goal of "competitive and technical balance with American producers" has been realized. Reflecting this reality--a reality which American policy was powerless to prevent over the past twenty years--the U.S. goal has changed to one of establishing new rules for government intervention in an industry of "mature adults," including a rule on the overall extent of public launch aid.

On the launch aid question, the United States has proposed that European subsidies be cut from about 75% of the total development cost of a new model to about 25% of the cost and that the aid be repayable at the going commercial interest rate, in equal installments, over a fifteen-year period dating from the first production of the model in question. This proposal is defended on the grounds that it will "level the playing field" between the American producers and Airbus, given an estimated 25% cost advantage of the former over the latter.[122]

The first real signs of a possible compromise on a cap for launch aid occurred in 1990, under the gun of a formal U.S. GATT complaint against an exchange-rate guarantee program for Airbus initiated by the German government. The program itself reflected growing European concerns about the budgetary toll of the Airbus program and its efficiency. In response to such concern, in 1988, the German government decided to sell MBB, the German state-owned member of the consortium. Daimler-Benz was the obvious candidate to purchase MBB, but it requested substantial government commitments to reduce the risk of doing so. Ultimately, the German government made several major concessions to Daimler's demands, including paying off MBB's outstanding Airbus production loans, rescheduling the repayment of outstanding launch aid, offering $1.6 billion in launch aid for the A330/340, and guaranteeing MBB against most potential losses that might result from a rising DM and a falling dollar.[123] The last of these concessions amounted to a guarantee

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[121] Estimates provided to the authors by the Department of Commerce.

[122] Information provided to the authors by the Department of Commerce.

[123] The maximum liability of the German government for the guarantees through 1996 is $1.3 billion, with another $863 million for the period 1997-2000. Office of Technology Assessment, Competing Economies, pp.205-207.

against losses on export sales resulting from exchange rate changes. Such an arrangement appeared to be an explicit violation of general GATT restrictions on export subsidies.

The provision of an exchange rate guarantee by the German government was a reflection of the very serious risk caused by exchange rate fluctuations in an industry, like aircraft, in which global sales are denominated in a single currency. In the aircraft industry, that currency is the dollar, and major fluctuations in its value relative to the European currencies can have big effects on the price-competitiveness of American and European producers. Of course, if currency fluctuations are the equilibrating mechanism for national trade imbalances, then these effects should be viewed simply as part of the natural equilibration process.[124] In 1988, the United States still had a huge trade deficit and Germany still had a huge trade surplus, so the dollar's drop and its competitive effects on Airbus and the American producers were precisely what was necessary for correcting macro imbalances. Indeed, the United States had been working with Germany and the rest of the G7 nations to bring the dollar down since late 1985 for this purpose. But macroeconomic imbalances were hardly paramount in the minds of the German officials and Daimler executives who negotiated the terms of the MBB sale.

They were, however, in the minds of U.S. officials who vigorously attacked the exchange-rate guarantee for Daimler. USTR Carla Hills called it "the most reprehensible type of subsidy. Much, much worse than the usual production subsidies. Once you subsidize currency fluctuations you're destroying the balance wheel that makes the trade mechanism work."[125] The United States was particularly concerned that the Daimler example would serve as a model for the use of exchange rate guarantees in other countries as a way to offset the effects of the dollar's decline on the price-competitiveness of their exports.

The United States filed a formal GATT complaint against the German exchange-rate guarantee program as a violation of GATT Article VI on export subsidies in late 1989. At the request of the German government, the United States put the complaint on hold, agreeing to discuss the program in the context of overall bilateral negotiations on all aspects of the aircraft dispute.

[124] On the other hand, when currency markets fluctuate wildly, with large effects on trade as happened in the 1980s, trade frictions inevitably result. This example demonstrates that the global economy ultimately faces a choice between managed trade and managed exchange rates.

Throughout 1990, under the gun of the pending complaint which was likely to lead to a GATT ruling favorable to the U.S. position, there were some promising signs of a possible agreement that would set a cap on launch supports. The Europeans offered a rate of 45%, which while higher than the 25% rate proposed by the Americans, was nonetheless a considerable reduction from their current practice of 75%. American negotiators pinned their hopes for a successful compromise on the growing strength of Airbus, the growing concern of the European governments about the budgetary implications of continued support, the privatization of the German member of the Airbus consortium, and the more aggressive anti-subsidy stance of the EC Commission, which in principle had the right to oversee and regulate the subsidy programs of its member governments.

Despite these auspicious contextual factors, however, the two sides failed to reach an agreement, even after the United States proposed an eleventh-hour compromise (in December 1990) of a 45% cap on launch aid for the first 2-3 years of a program, dropping to 25% thereafter. In early 1991, talks between the two sides broke down, leading the United States to reactivate its GATT complaint against the German exchange-rate subsidy and to initiate a second complaint against other Airbus subsidies as a violation of the 1979 Aircraft Code itself.[126] In early 1992, a GATT panel ruled in favor of the United States in the former case and sent its decision for review to the GATT Subsidy Committee. Meanwhile, the latter case--referred to the Subsidies Code Committee for consultation--led to the resumption of bilateral negotiations.

Then in a stunning development in April 1992, the United States and Europe revealed a tentative compromise agreement encompassing most of the issues summarized in Table 5-9. According to still sketchy preliminary information, the agreement specifies the level, terms, and conditions for development support, including an overall cap of 30%-35%.[127] In addition, the deal caps allowable indirect subsidies at 5% of the value of a company's sales of commercial aircraft. Consistent with the American emphasis on transparency, the proposed arrangements require timely publication of subsidy information and regular meetings twice a year to monitor compliance.

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[125] Keith M. Rockwell, "Airbus Subsidy Tied to Currency Infuriates U.S.," The Journal of Commerce and Commercialization, October 2, 1989, p.1.

[126] Both of these actions were taken under the GATT Subsidies Code.

[127] Roger Cohen, "US and Europeans Agree on Reducing Aircraft Subsidies," The New York Times, April 2, 1992, p.1.

Consistent with the European position, the new restrictions apply only to future subsidies; past subsidies to Airbus are exempt.

The compromise agreement recognizes a fundamental reality: given the industry's underlying economics, subsidies cannot and should not be ruled out altogether. The challenge is to write subsidy rules as parsimoniously and precisely as possible to encourage beneficial innovation and competition while minimizing the risk of rent-shifting subsides by one side or the other, with deleterious, rent-dissipating consequences for both. Moreover, since the pressures for abusing the rules will always exist, they must be supported by strong transparency and enforcement mechanisms. The April 1992 agreement appears to be a major step toward meeting these challenges.

Both sides finally compromised because they recognized that they stood to benefit from an agreement that accepts the existence of industrial policies in the commercial aircraft industry, but eliminates certain kinds of beggar-thy-neighbor and efficiency-reducing subsidies, such as export subsidies, inducements, and production subsidies, and scales back other kinds of subsidies, especially various launch aid subsidies. In addition, given their first-mover advantages, both sides share an interest in developing multilateral disciplines on future subsidies by other governments. On the European side, the growing market strength of Airbus contributed to greater willingness to yield on the question of launch aid, especially as a first step toward deterring the entry of new subsidized foreign competitors. In this regard, the pending deal between MD and Taiwan Aerospace may have encouraged the Europeans to compromise in the expectation that a bilateral deal with the United States could be extended to cover the possible provision of subsidies by Taiwan and other Asian governments to MD or to another commercial aircraft venture in the future.

The 1992 agreement should also be understood as an effort by both sides to halt the escalating risk of a trade or subsidy war. By 1991, American patience with the Europeans was wearing thin. Infant-industry subsidies to level the playing field were one thing; continued generous beggar-thy-neighbor subsidies to grab market share were quite another. Even Boeing, which had counseled patience, was signaled that eventual unilateral American action would be required if

bilateral negotiations failed.[128] The threat of a real trade confrontation was exacerbated by excess capacity conditions likely to persist throughout most of the 1990s,[129] encouraging the use of subsidies and inducements for rent-shifting purposes. As argued in the next section, if the proposed deal between MD and Taiwan Aerospace becomes a reality, this threat will be sharply intensified.

To head off this threat, the United States must recognize that what is good for the goose is good for the gander--it cannot require that the Europeans restrict their subsidies to Airbus, while allowing other foreign governments to subsidize American producers without restriction. In particular, the United States must not allow its pathbreaking agreement with the Europeans to be jeoparadized by the provision of subsidies by Taiwan or other foreign governments to MD or Boeing.[130] In the absence of such an agreement, a trade war or a market-sharing arrangement, as some Europeans have suggested as an alternative, would reduce the gains from trade and competition, undermine the web of crossnational production alliances, and ultimately threaten the international trading system.

Finally, before leaving this section on trade policy responses to the Airbus challenge, it is important to raise the question: could the United States have used either its own trade policy or GATT more effectively in this case? The answer appears to be no. First, as argued earlier, it is not clear that the United States is worse off as a result of past Airbus subsidies, once the dynamics of competition and technological innovation are brought into the picture. Second, even assuming that these subsidies have been net welfare-reducing for the United States, there is a strong presumption that some sort of protectionist response would have only made matters worse. The analytical

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[128] Boeing is understandably intent on trying to reach some "level-playing-field" agreement on the launch subsidy question before Airbus makes good on its intention to launch the 350 which would pose a major competitive alternative to the Boeing 747. In a recent speech before the Council on Foreign Relations, Boeing CEO Frank Shrontz argued that "enough is enough" and expressed his opinion that Boeing had a strong case for retaliatory action against Europe under US trade law.

[129] According to Wall Street projections, with which Boeing officials largely concur, total annual demand for new aircraft deliveries is not likely to exceed 600 airplanes per year for the next decade, while current aircraft capacity is 1000 airplanes per year and climbing.

[130] As part of its co-development deal with four Japanese companies for the 777, Boeing indirectly receives some subsidy benefits from the Japanese government. Boeing steadfastly claims that these benefits are relatively small, and a recent OTA study bears out this claim. According to the OTA, Japanese companies' 20% participation in the 777 will probably cost $1.2 to $1.3 billion. Of this, $700 million is development support, half of which is eligible for MITI support. The OTA figures are cited in the written testimony of John Wolf, Executive Vice President of Douglas Aircraft Company, before the Joint Economic Committee, February 27, 1992. For more information on possible subsidies for McDonnell-Douglas as part of its deal with Taiwan Aerospace, see Section VI below.

literature makes a strong case that countermeasures against foreign subsidies are often ineffective or harmful--in short, the cure is worse than the disease. Certainly, the American producers would have been hurt even more than the European producers by a tit-for-tat round of protectionist measures that reduced sales in one another's markets. In any event, a strong unilateral American trade policy action that threatened retaliation has not been a viable option because of the American industry's strong opposition. Nor, for the same reason, has a tit-for-tat subsidy response been a viable option--throughout the aircraft dispute with Europe, Boeing has been a steadfast opponent of a countervailing subsidy approach,[131] and it has exercised considerable influence over policy choices. Moreover, it seems unlikely that either a unilateral trade policy action or a subsidy response by the United States would have deterred European efforts to realize what has been their long-term goal of building a competitive aircraft producer.

The real policy error that emerges from the postwar history of the aircraft industry is the error of an incoherent industrial policy, not the error of an ineffectual trade policy. Given the strong links between the military aircraft industry and the commercial aircraft industry during most of the postwar period, a defense-oriented industrial policy in the former had profound effects on the latter, influencing willy-nilly both the identities of the producers and the terms of their competition. Perhaps most important, all of the American commercial aircraft producers were provided with an implicit insurance policy--regardless of their commercial sins, their military operations were secure. In the 1970s, armed with new engine technology financed by the military and protected by such insurance, the three American commercial aircraft producers embarked on a series of extremely risky commercial strategies. Even Boeing's strategy, which today looks brilliant, was highly questionable at the time. Both by today's standards and by the standards of the time, the decisions of Lockheed and MD to introduce essentially the same aircraft in a head-to-head competitive battle were obviously ill-fated. Caught in a classical prisoner's dilemma situation, each company would have been better off with a coordinated decision. In the absence of a coordinating agent, however, each chose to act in its own private interest, with negative results for both of them and for the national interest. If the American government had stepped in to head off the mutually destructive

[131] Boeing's position on the issue of domestic subsidies may reflect its judgement that in a subsidy war with Europe, the US side would come up short or that in such a war, McDonnell-Douglas, its major American competitor, would get the

competition between them, the American industry would have been financially stronger and the market opening into which Airbus waltzed might not have developed. Such a coordinating role by the American government would have required an understanding of the strategic commercial significance of the aircraft industry and of the dynamics of its marketplace. Unfortunately, while the U.S. government was willing to pick military winners and losers, with significant but unintended market influence, it was unwilling to play the role of market coordinator at a critical moment.

The American industry is now at another critical historical juncture which, ironically, has its roots in this earlier policy failure. MD is currently in serious financial difficulty, both as a consequence of its dwindling share of the commercial market and as a consequence of substantial cutbacks in its military operations. Contrary to what some American observers have suggested, the company's woes are not simply the result of European subsidies to Airbus, although Airbus has cut most deeply into its market share. Rather, its commercial problems can be traced to more than two decades of undercapitalization and relatively stagnant technology, brought on by its earlier competition with Lockheed.

Recently, a white knight, in the form of Taiwan Aerospace, has appeared with a possible plan to save the commercial operations of MD. Since Taiwan Aerospace is essentially a shell for Taiwanese private and government money, and since MD is the nation's major military contractor, the proposed deal, which from the company's point of view is necessary for its commercial survival[132], has raised policy concerns in the United States. Even if the deal ultimately falls through, it raises important questions about the appropriate national policies for the nation's commercial and military aircraft industries now that the Cold War has ended. How the nation confronts the challenges posed by the current difficulties of MD will provide a test case for how the nation will confront the challenges of converting from military to economic priorities in a post Cold War world.

VI. Taiwan Aerospace and MD: A Strategic Perspective on the National Interest in the Commercial Aircraft Industry.

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lion's share of domestic support because of its weaker financial position.

[132] MD's reasons for the deal with Taiwan Aerospace are described in the testimony by John Wolf, Executive Vice President of Douglas Aircraft Company, before the Joint Economic Committee on February 27, 1992.

In 1991, MD, the nation's largest military contractor, was in serious financial difficulty. Even its military operations were in jeopardy, partly as a result of the cancellation of the A-12 Stealth aircraft project. Indeed, during the first half of the year, the company temporarily deferred payment on a $1.35 billion debt to the Department of Defense and requested an advance of $1 billion from the Pentagon, reportedly because of serious cash flow problems. Meanwhile, as Defense Department officials worried about how to save the company's military operations, a growing number of analysts predicted that it would be forced to exit from the commercial aircraft industry. As noted earlier, the company had encountered both technical and cost problems in its new MD-11 and was losing market share to Airbus.

In an effort to remain a player in commercial aircraft, MD approached a number of private American companies, looking for an equity partner to share the development cost and risk on its proposed new MD-12 model. Ironically, Lockheed was one of the companies that discussed the deal with MD, but ultimately turned it down. MD's strategy in seeking partners for the MD-12 was understandable. With only two models, MD cannot compete with the five-product families of Boeing and Airbus. Unless it can develop a new aircraft to restore customer confidence in its long-term viability, it will lose future orders for its existing MD-80 and MD-11 models. Although it needs to launch a new model to survive, however, MD does not have the capital to do so.

Unable to find private sources of capital in the United States, MD engaged in discussions with the newly formed Taiwan Aerospace, a public-private company established to develop an aerospace industry for Taiwan. In November 1991, a preliminary deal between the two was announced. According to the proposed terms, Taiwan Aerospace would put up $2 billion to purchase a 40% equity share in the Douglas commercial aircraft company.[133] Of this amount, at least 29% would be provided by the Taiwanese government, as a shareholder of Taiwan Aerospace. MD would use the money to retire the lion's share of its outstanding $2.7 billion debt and to begin development of the MD-12. Taiwan Aerospace, as an equity shareholder of Douglas Aircraft, would be involved in the manufacturing and marketing of the MD-12, as well as the MD-80 and the MD-11, the company's other models. Finally, McDonnell Douglas indicated that it was also courting

[133] By March 1992, the Taiwanese government was already having second thoughts and was considering reducing its purchase to a 25% equity share in Douglas aircraft.

other East Asian investors to put up another 10% equity share, for a total of 50% foreign ownership of its commercial operations.

For MD, the proposed deal is a godsend. To remain a player in the commercial market, the company needs a substantial infusion of new capital. But private American investors are unwilling to participate in the MD-12 project. The deal with Taiwan Aerospace provides substantial upfront capital and also holds the promise of additional funds to cover the costs of launching the MD-12. In addition, MD believes the deal will improve its access to East Asian markets. Finally, the company is attracted by the lure of highly skilled but relatively inexpensive East Asian engineers and workers.

On the Taiwanese side, the motives for the deal are equally transparent. The Taiwanese government has accumulated huge foreign reserves, currently estimated at about $77 billion. It has also targeted the aerospace industry, not because of its commercial profitability, but because of its special economic benefits for technology development, export development, and skilled employment development.[134]

Despite protestations to the contrary, there is also a national security aspect to the Taiwanese decision. Because of pressure from China on the advanced industrial countries, including the United States, Taiwan cannot buy advanced military aircraft. An investment in the development of a commercial aircraft capability now may pay off in the development of an improved military aircraft capability sometime in the future.

While the Taiwanese government has been thinking carefully about the proposed deal, the American government has paid scant attention. Behind the American attitude is the presumption that what is good for a private company like MD is good for the nation. Although ideologically soothing, this presumption is irrelevant to the case at hand. MD is no ordinary private company--it is the nation's largest military contractor and the guardian of some of its most sensitive military technologies. And the proposed deal with Taiwan Aerospace is no ordinary market transaction--it involves the active participation of the Taiwanese government, without which the deal would

[134] Given the excess capacity in the global commercial aircraft industry described in the text and the weak financial and technological capability of McDonnell-Douglas, the Taiwanese decision cannot be understood on commercial grounds. Furthermore, the Taiwanese government has announced its intention to establish a commercial aircraft industry and to support it through a variety of means, including tax breaks and low-interest loans. See, the China Aeronautics and Space Industries Development Program, published by the Ministry of Economic Affairs. Public Notice No. Ching (79) Kung 040484, August 1990.

collapse. Although the deal, once finalized, will be reviewed by CIFIUS, its record to date strongly suggests that the deal will be approved on narrow national security grounds without conditions. Meanwhile, there has been no attempt by the American government to influence the terms of the deal on commercial grounds despite the active participation of the Taiwanese government on the other side of the bargaining table.

Many American observers see the deal as simply a modest extension of the globalization trend apparent in the aircraft industry since the late 1970s and encouraged by the 1979 Aircraft Agreement.[135] Moreover, the overall assessment of this trend is a positive one--globalization has enhanced production efficiency and improved market access and competition.[136]

Some observers worry about the transfer of sensitive military technology to MD's foreign partners, but the company has promised to structure the deal to prevent this.[137] Others worry that the transfer of commercial aircraft technology and the creation of aerospace skills in Taiwan will ultimately result in the emergence of an independent East Asian producer of commercial aircraft which will pose a competitive challenge to the American industry. But most informed analysts discount this possibility for the foreseeable future. As the Airbus experience demonstrates, the barriers to entry and market access in the prime contractor tier of the global commercial aircraft market are huge and are unlikely to be overcome quickly, if at all, by late-entrants lacking indigenous technological and manufacturing experience.[138] In addition, the deal is structured so that the most sophisticated systems-integration parts of the joint venture will remain in the United States with Douglas aircraft, while its East Asian partners participate mainly as joint financiers and subcontractors.

A more serious policy concern raised in conjunction with the proposed deal is its possible adverse effect on the subcontractor and supplier tier of the American aerospace industry. According to some reports, as much as 60% of the work on the MD-12 will be done in Taiwan if the deal goes through. The subtier of the American aerospace industry has already been hurt by earlier global

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[135] David Mowery, "International Collaboration in the Commercial Aircraft Industry: Assessing the Taiwan Aerospace-McDonnell Douglas Agreement," Testimony before the Joint Economic Committee, December 3, 1991.

[136] T. Moran and D. Mowery, "Aerospace and National Security," pp.29-34.

[137] John Wolf, Executive Vice President of Douglas Aircraft, described how the company will structure the deal to avoid national security risks in his written testimony before the Joint Economic Committee on February 27, 1992

deals by both MD and Boeing in Europe,[139] Japan, and elsewhere designed to secure market access in what remains a heavily politicized world market for commercial aircraft sales. But even if the proposed deal between MD and Taiwan Aerospace hurts American subtier suppliers, the market-driven exit of MD from commercial aircraft production altogether would hurt them even more. Of course, this still leaves open the possibility that the American government might intervene in the deal to negotiate better terms for American suppliers.

Indeed, active participation by the American government in negotiating and monitoring the deal is warranted, both because the Taiwanese government is directly involved and because MD is the nation's chief military contractor. At the very least, the Administration and Congress should work with McDonnell Douglas and representatives of its subtier supplier firms to bargain for greater employment and subcontracting opportunities at home.[140] American government representatives must also be involved in some kind of oversight capacity to make sure that the deal does not transfer militarily sensitive technology. Consistent with these objectives, a framework should be developed for public monitoring of the deal's technology-transfer and subcontracting arrangements. Finally, the United States must negotiate with the Taiwanese on the amount and kinds of subsidies that will be allowed as part of their arrangements with MD. The company will need anywhere from $5 billion to $10 billion dollars to develop the MD-12.[141] Where will this money come from? In the unlikely event that private Asian investors supply all the necessary funds, there is no public policy

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[138] This concern would be much more compelling if McDonnell-Douglas' equity partner were Japan, which has increasing supply control over critical aircraft components, especially advanced avionics.

[139] According to ITA estimates cited by Michael Farren, the percentage of foreign products (excluding the engines) installed on the Boeing 767 probably represent closer to 15%, and on the 777 may be as high as 30%. For McDonnell Douglas, foreign products (excluding the engines) range from 15%-20% of the aircraft value of the MD-11 and MD-80/90, up significantly from the foreign content of the older DC-9 and DC-10. These figures are cited in Farren's written testimony before the Joint Economic Committee on February 27, 1992.

[140] One might argue that if the U.S. government becomes involved in negotiating the subcontracting terms of the deal, it will encourage other countries to do the same in deals involving American companies. But other countries already do this, and lack of action by the U.S. government has failed to deter them. The real question is whether the U.S. government should take a more active role in negotiating deals when other governments are already participants, not whether the U.S. can block their participation by setting a hands-off good example.

[141] McDonnell Douglas reports estimates of the total investment cost for the MD-12 program in the $4.0 - $5.4 billion dollar range. Boeing believes that the actual amounts will be much higher, in the $7.0 - $10.0 billion range, including upfront investment costs as well as cumulative negative cash flow during the first years of the production. Moreover, Boeing believes that this is a lower estimate based on the assumption that the MD-12 is ultimately a market success. Now that MD is considering an all-new aircraft, the actual number is likely to be closer to Boeing's estimate. Testimony by Larry Clarkson, Boeing Vice President, before the Joint Economic Committee, February 27, 1992.

problem. But in the more likely event that the Taiwanese or other East Asian governments offer the bulk of development financing on non-market terms, the implementation of the deal may violate the GATT Subsidy Code, the 1979 Civil Aircraft Code, the 1985 OECD agreement on export financing, or the recently announced, still precarious and untested, bilateral subsidy agreement with the Europeans.[142]

A violation of any of these arrangements, especially the latter, may well ignite a mutually destructive trade or subsidy war between the United States, Europe, and Asia, undermining the hard-earned results of fifteen years of often acrimonious negotiations. In addition, if no restrictions are set on possible Taiwanese subsidies to MD, Boeing is likely to find itself confronted by a heavily subsidized Asian competitor and a still subsidized European competitor at the same time.

To avoid the threat to existing subsidy agreements and to Boeing posed by an unrestricted deal between Taiwan Aerospace and MD, the United States should demand an upfront commitment by Taiwan to honor these agreements. Such a commitment is critical because Taiwan is not a member of GATT or the OECD. In addition, it has a long history of infringement of American trade laws, especially those dealing with the protection of intellectual property. Finally, because the joint venture between Taiwan Aerospace and MD would be 50% American-owned, Boeing could not bring a GATT complaint against the venture even if Taiwan were to become a GATT signatory. Therefore, the only reliable way to impose conditions on Taiwanese subsidies is to negotiate them as part of the deal from the beginning.

The active participation of the American government on questions of technology transfer, subcontracting, and allowable subsidies may itself derail the deal or lead to its early demise, especially if, as seems likely, the additional launch money for the MD-12 cannot be raised from private sources and requires government subsidies that would violate multilateral agreements or the recently announced bilateral agreement with the Europeans. But this minimalist policy package begs the bigger question of whether the American government should intervene to stop the deal in its

[142] Although MD assiduously denies that any subsidies will be involved, the evidence suggests otherwise. As already noted, development of the MD-12 will entail huge launch costs, which, given the conditions of excess demand in the marketplace and the credible commitment of continued European subsidies to Airbus, private American investors will not provide. Moreover, statements by officials of Taiwan Aerospace indicate that they expect subsidies from the Taiwanese government will be available as needed. For example, the Chairman of Taiwan Aerospace stated in a December 1991

current form. And the answer to this question depends in turn on the answer to a more fundamental question: would the subsidized launch of the MD-12 be in the national interest.

As the earlier history of aircraft competition presented in this chapter indicates, the answer to this question requires a balancing of consumer and producer interests and of static and dynamic efficiencies. On the one hand, the entry of a new aircraft, especially under conditions of global excess capacity, is likely to reduce prices, benefiting airline companies and their passengers. In addition, depending on its design, a new aircraft might provide consumer benefits in the form of greater product choice and enhanced product capabilities. On the other hand, greater competition is likely to reduce economies of scale for each producer and raise industry costs. Higher costs, combined with lower prices, are likely to dissipate industry rents, making all producers worse off. Boeing as the only "unsubsidized" producer is likely to feel the pinch the hardest. And reduced profits in turn would hamper its ability to meet the challenge of a subsidized A350 entry later in the decade. In short, the entry of the MD-12 now may well reduce the American industry's long-term competitiveness vis a vis Airbus.

This effect, like the other effects of a new product on consumer and producer welfare, depends on the nature of the product itself. If it offers little in the way of new technology or product differentiation, it is more likely to be simply rent-dissipating, affording little by way of a sustainable product niche or first-mover advantage to its launcher, while harming the industry's other producers. The history of the industry, especially the episode of mutually destructive competition between MD and Lockheed, reveals the dangers of excessive and duplicative competition.

In light of these general considerations, what can be said about the likely effects of the subsidized entry of the MD-12 on American economic welfare? It is important to begin with the product design itself. In its initial discussions with Taiwan Aerospace, MD proposed a 375-person, trijet MD-12. This model is a "stretch" version of the MD-11 which is itself a derivative of the DC-10. With a new wing and larger engines, the trijet MD-12 should be able to fly an estimated 8000 nautical miles.[143]

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speech that the Taiwan government would "continue to invest in TAC (Taiwan Aerospace Company) until it makes a profit." His comment was reported in the Far Eastern Economic Review, February 13, 1992.

[143] "Douglas Increases MD-12 Win Area, Engine Size to Enhance Performance," Aviation Week and Space Technology, November 4, 1991. p.33.

As planned, the MD-12 would enter a market segment surrounded by the 747 and four new wide-bodied aircraft: the MD-11, 777, A330, and A340. The product would be undifferentiated horizontally in terms of size and range and vertically in terms of performance criteria such as fuel efficiency and personnel requirements, basing itself on the designs and technology of the 747. What this MD-12 product strategy reflects is not the most promising niche of market demand but MD's short-term mentality necessitated by its immediate cash-flow problems. An optimal product strategy unconstrained by financing difficulty is an all-new 600+ seat, super-jumbo, long-range jet of the type envisioned by Airbus for its A350. Such a model would address the long-term needs of airline companies in a world in which passenger traffic growth will soon outstrip new airport construction and existing airport facilities.

The entry of a commercially undifferentiated MD-12 would dissipate Boeing's 747 rents without delivering significantly greater product choice or advanced technology to airlines and consumers. As an MD official admitted in the March 16 issue of Aviation Week and Space Technology, the trijet MD-12 would not "offer customers anything they couldn't get anyplace else."[144] MD's stated target for the trijet MD-12 is Boeing's profit in the high-capacity long-range market.[145] Ironically, while Airbus was MD's major competitive challenge, the trijet MD-12 would actually attack the profit base of Boeing's market leadership, with Airbus as the major beneficiary.

As an undifferentiated product, the trijet MD-12 would raise costs and reduce production efficiency in the aircraft industry. The MD-12 would be a high-cost aircraft for two reasons. First, many of the people involved in its production would have little or no experience producing a commercial aircraft. Thus the learning economies embodied in more experienced workers would be missing this time around. This will be true regardless of the actual design for the MD-12 which finally emerges. Second, the trijet MD-12, as a twice-derivative, would not have a long product life cycle. Its replacement by a super-jumbo jet would be likely by the end of the decade. Without a long production run, however, costs on the MD-12 would remain high. Thus, while Boeing's profits would probably fall as a result of the MD-12 competition, it is unlikely that MD would see an offsetting increase in its profits because of the high cost and short life of its product. Profits would

[144] Bruce A. Smith, "Four Engines, Double Decks Mark All New MD-12 Design," Aviation Week and Space Technology, March 16, 1992, pages 14-15.

be reduced, not simply shifted from one producer to another, for the American industry as a whole. At the end of the day, it is unlikely that the trijet MD-12 would solve MD's long-run profitability problem. At best, it would remain the number three producer in the industry; at worst, it would have prolonged its exit. In either case it would have hurt Boeing in the process.

Since each 747 is likely to be considerably cheaper to produce than each MD-12, any potential gain in MD's market share would also increase average industry costs and reduce average industry efficiency. For all of these reasons, it is likely that the entry of the trijet MD-12 would be welfare-reducing for the American industry as a whole. From the industry's perspective, the deal between MD and Taiwan Aerospace to develop this product looks to be a negative-sum game.

Perhaps in recognition of some of the shortcomings of the trijet MD-12 product strategy identified here, MD has recently begun to consider an alternative all new four-engine, double-deck, super-jumbo design for the MD-12.[146] So far, the new proposal has been better received by the airlines and engine suppliers. It is also superior in terms of its likely effects on national economic welfare. Unlike the trijet design, the super-jumbo design would entail real product innovation, offering greater choice and improved technology. In addition, the super-jumbo MD-12 might give the American industry a first-mover advantage over Airbus in the most promising future market niche. For the time being, Boeing, as the incumbent producer earning profits in the 747 market, is reluctant to move first into this new market. And Airbus, which would like to exploit a first-mover advantage, is waiting for more auspicious demand conditions. MD, on the other hand, must introduce a new model to sustain its commercial business, even though demand conditions are not promising. Under these conditions, it would be better for MD to try to capture a first-mover advantage in the super-jumbo market than to initiate a war of attrition with Boeing in the 747 market by launching a derivative trijet design.

Even though the super-jumbo MD-12 strategy would be preferable to the trijet MD-12 strategy in terms of its likely effects on national economic welfare, it still has a major shortcoming. It is likely to encourage premature and excessive entry by Boeing, Airbus, and MD into the super-jumbo market. The global aircraft market is currently suffering from excess capacity which is likely

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John Wolf, Written testimony before the Joint Economic Committee on February 27, 1992. pp.6-7.

to persist for the foreseeable future. If all of the major producers attempt to launch new aircraft under these conditions, it is likely that aircraft prices will continue to soften, profits will decline, the pressures for government subsidies will grow, and friction between the United States, Europe and Asia in the aircraft industry will intensify. In short, a subsidized three-way race for the super-jumbo market is likely to translate into excessive, duplicative competition, spilling over into dissipated profits for producers and trade conflict among producing nations. In this competition, Boeing would confront subsidized competitors from two sides, and the temptation for the U.S. government to introduce offsetting subsidy relief for Boeing, under terms consistent with the tentative agreement with the Europeans, might well become irresistible.

What are the prescriptions for a "maximalist" American policy response to the proposed deal between MD and Taiwan Aerospace that emerge from the preceding analysis? First, the United States should discourage a deal that involves the launch of a trijet MD-12 model. Second, even though a deal to launch a super-jumbo model is preferable in some respects, it carries the considerable downside risks of costly duplicative competition, intensifying trade friction, and a possible trade or subsidy war. To avoid these risks, the U.S. government should provide support and leadership for a forward-looking, domestically-based rationalization plan for MD's commercial and military operations. At the same time, such a plan would head off MD's exit from commercial operations, an outcome which looks inevitable in the absence of either domestic or foreign government intervention.

Third, a rationalization plan for MD should be part of a broader plan to support the conversion and rationalization of the nation's other military aircraft operations. The American aircraft producers and their suppliers should participate in the formulation of these plans. They should be designed to reduce the adjustment costs and speed the inevitable process of conversion dictated by the post Cold-War environment. They should guarantee that the American industry will have the financial and technological capacity to meet the inevitable Airbus 350 challenge sometime during this decade. Ultimately, the most effective discipline on European actions in the aircraft industry is a credible commitment of American capabilities to match them.

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[146] Bruce smith, "Four Engines, Double Decks Mark All New MD-12 Design," Aviation Week and Space Technology, March 16, 1992.

A public-private solution to the current difficulties of MD would not be a deviation from past American policy in the aircraft sector. One need only recall the earlier moves by the government to promote the merger of McDonnell and Douglas and to ease the gradual exit of Lockheed through a temporary loan guarantee. Nor need such a solution preclude the participation of Taiwan or other interested East Asian countries. The American industry stands to gain from closer links with the dynamic East Asian markets and from the cost and production efficiencies of subcontracting relationships with East Asian suppliers. Taiwan and some of the other East Asian nations, in turn, are strongly interested in developing an indigenous aerospace capacity for the reasons noted earlier, and they have the financial willingness and wherewithal to do so. Compared to Europe, the United States has a strong advantage in forming partnerships with these nations because of stronger trade and geopolitical links with them. Taiwan, like South Korea, is well aware of its dependence on the defense umbrella provided by the United States. As a result, the United States still exercises tremendous leverage in these countries, leverage that can be used to promote cooperative deals in the aerospace industry that benefit all sides. The problems with the proposed deal between MD and Taiwan Aerospace are its terms, not the fact that it involves the active participation of Taiwanese investors, including the Taiwanese government. A better structured deal, designed with upfront conditions on technology transfer, subcontracting, subsidies, and financing for the launch of an aircraft embodying significant technological breakthroughs, could prove beneficial to all participants.

A rationalization plan for the American industry should also take a hard look at the issue of possible strategic dependence on foreign suppliers of critical component technologies, such as advanced avionics systems. As Moran and Mowery argue, "a foreign stranglehold on the provision of a critical component or technology would be a very potent source of leverage in this industry, reliant as it is on the integration and assembly of a vast array of sophisticated inputs into final products. Moreover, since the components frequently are employed in both defense and civilian applications, supply constraints conceivably could carry with them a broad spectrum of military as well as political and economic risks."[147]

[147] T. Moran and D. Mowery, "Aerospace and National Security," pp.49-50.

The United States lacks even the information required to assess whether the threat of supply constraints in critical aerospace components should be taken seriously. Even a minimalist policy agenda for the domestic aircraft industry should require regular monitoring of the supply base for some components. Within the rubric of the maximalist agenda suggested here, an industry rationalization plan should encourage the development of additional alternative sources of domestic supply in warranted cases.

Sadly, it is almost impossible to imagine that the United States will adopt either the minimalist or the maximalist policy agenda proposed here.[148] Few of the strategic questions about the possible adverse effects of the MD/Taiwan Aerospace deal have even been raised in the public debate. This reflects a woeful lack of strategic vision in national policy circles about what is arguably the nation's most strategic industry. Ideologically, policy makers remain committed to the fiction that market forces should determine competitive success, even though the most cursory reading of American economic history indicates that a defense-oriented industrial policy has been a major factor behind such success in the aircraft industry.

As the United States scales back its defense efforts, policy makers must discard their ideological blinders and refashion the nation's unwitting, back-door industrial policy into a commercially-oriented economic strategy for high-technology industries. For obvious military and economic reasons, the aircraft industry is the place to begin the necessary ideological conversion.

Indeed, although the Administration recognizes the significant challenges now confronting the American aircraft industry, it is offering only a weak and aggregate response, consisting of a reduction in the capital gains tax, support for basic generic research, support for successful conclusion of the Uruguay Round, and ITA-supported trade missions and airshows. This was the package proposed by Undersecretary of Commerce Michael Farren in his testimony before the Joint Economic Committee on February 27, 1992.